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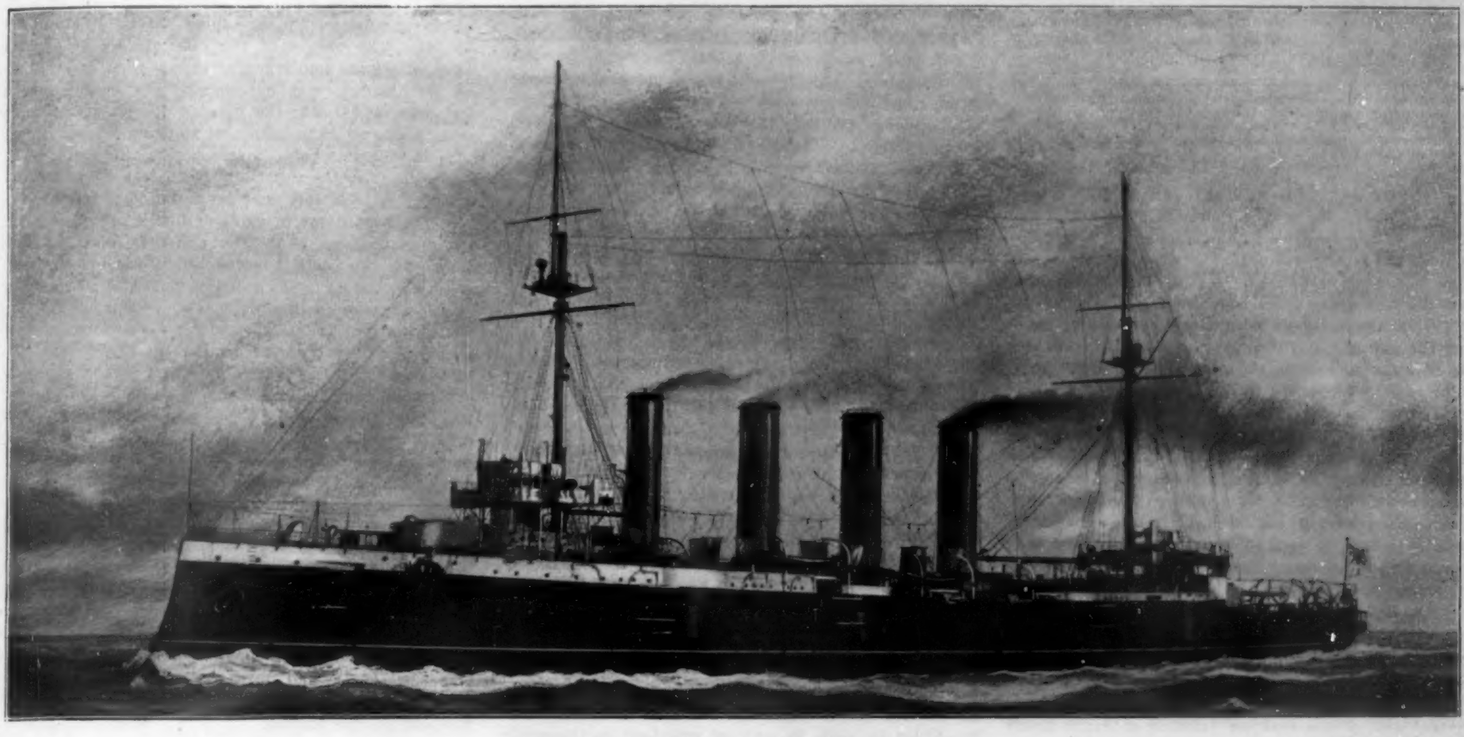
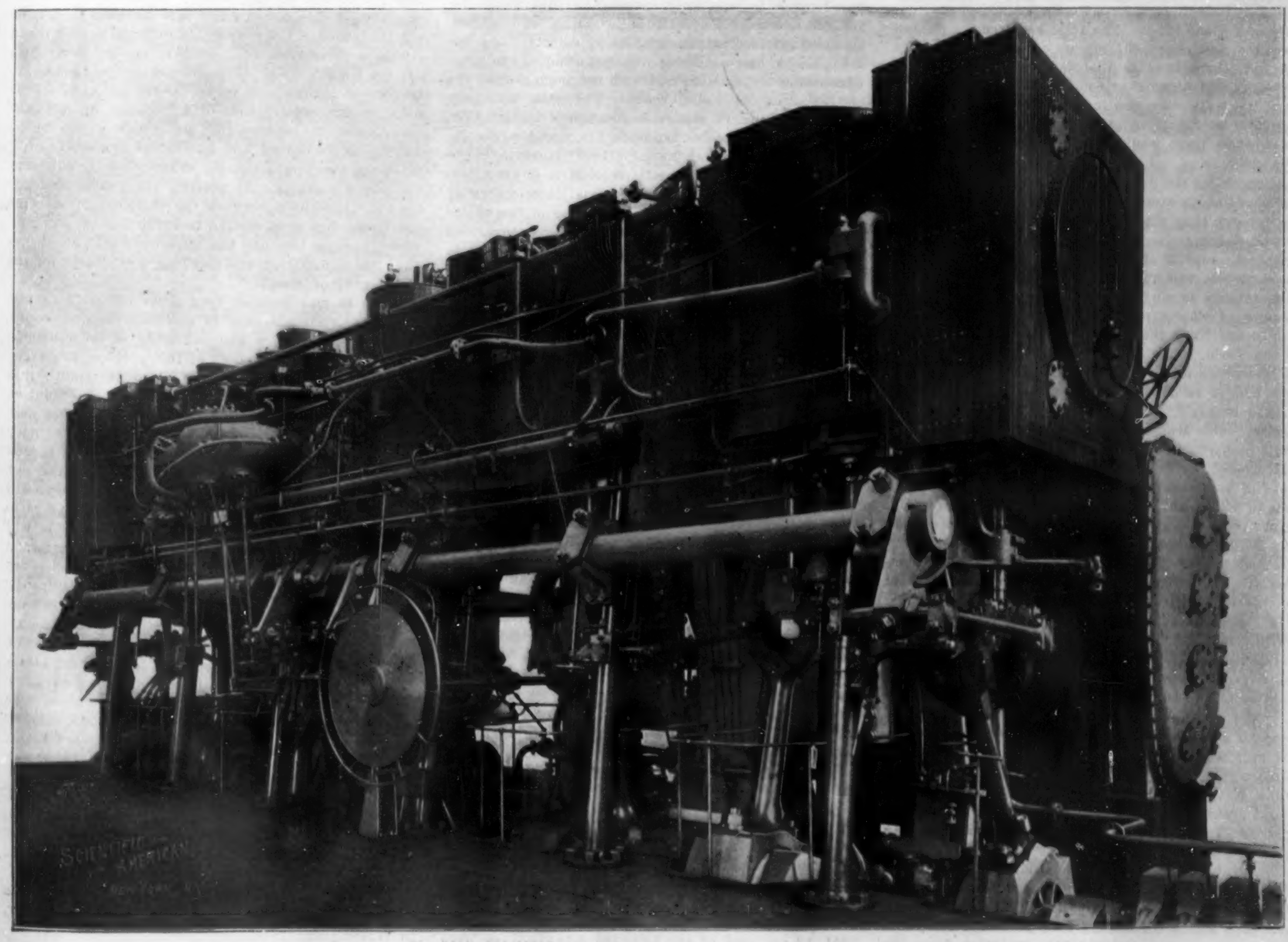


NEW BRITISH ARMORED CRUISER "GOOD HOPE."

Displacement, 14,100 tons. **Speed,** 23.05 knots. **Maximum Coal Supply,** 2,500 tons. **Armor,** belt, 6 inches, gun positions, 6 inches. **Armament,** two 9.2-inch; sixteen 6-inch rapid-fire; twelve 3-inch rapid-fire. **Torpedo Tubes,** 2. **Complement,** 900.



ENGINES OF THE "GOOD HOPE."—INDICATED HORSE POWER ON TRIAL, 31,071.—[See page 257.]

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ESTABLISHED 1845

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MUNN & CO., 361 Broadway, New York.

NEW YORK, SATURDAY, OCTOBER 18, 1902.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

THE PRESSING NEED OF OUR NAVY.

There is need for a very thorough agitation of the question of the increase in the number of our naval officers; for it is certain that neither the people at large nor their representatives in Congress appreciate the very grave crisis which has been precipitated by the failure to make adequate provision for manning the new ships of the Navy. It is easy to understand, if not to excuse, the ignorance or indifference which exists with regard to this question, which is due doubtless to the fact that we are more affected by what we can see with our own eyes in the shape of big battleships, powerful cruisers, etc., than we are by statistical figures indicating the present and future strength of the personnel for manning these ships. For several years past it has been perfectly well understood in official circles that we were building new vessels very much faster than we were providing men and officers to man them; but up to the present time Congress has shown a strange apathy in dealing with the situation. The matter, however, has come to such a pass that this question will be one of the most, if not the most, important that will confront the next Congress, and as the following figures, given by the Secretary of the Navy, prove, the matter will not admit of the least delay.

At the beginning of the present year there was a demand for the proper manning of the serviceable ships of our Navy of 1,237 officers of the line, and at the same time there were 264 officers engaged on shore duty of various kinds. The total requirement on January the first was 1,631 officers. On the same date, however, there were in the Navy only 1,023 officers, including midshipmen, or 608 less than were required. Even if we allow for the fact that about one-fourth of the ships of the Navy are out of commission during peace times, there would still be a shortage of 300 officers.

So much for the present. With regard to the future the situation is even more alarming, for we have at the present time sixty or seventy vessels authorized, or under construction, of which several are the largest and most powerful of their kind in the world. To man these vessels will require 498 additional officers, and this estimate is made on the basis of a minimum allowance of officers per ship, the allowance being far less in our Navy than in any of the first-class navies of the world. This is proved by the fact that, while in this estimate the United States allows only seventeen officers to a battleship, Germany allows twenty, France twenty-six and England thirty-three, or practically double what we do. If we estimate that the usual proportion of officers will be on shore leave, sick, on furlough, or in transit from foreign to home stations or vice versa, we must have 623 officers on the lists to man these ships with the 498 that they require. In the intervening four years between the present date and the completion of these vessels, it is estimated by the Secretary of the Navy that no less than 160 vacancies will be created by the death of officers, or by their leaving the service through disability, or by resignation. Adding these to the total already arrived at, we find that 783 officers will have to be provided for the ships now in course of construction, all of which are expected to be in commission by 1906. Add this number to the 608 officers which we are short of today, and we find that by the date named, if we are to properly officer our fleet, even on the limited number per ship which we allow, there will be required 1,391 officers, or a total of more officers than we have in the whole Navy to-day.

But even these figures would not represent our total need in case of war, for, as in the Spanish-American conflict, a considerable number of naval officers would have to be transferred to auxiliary vessels which would be taken up by the Navy to meet the emergency. These officers could not be drawn from the Naval Academy, for in the coming four years the Navy can only reckon upon receiving 355 graduates from the Academy and this would still leave us more than a thousand officers short of the proper complement. It is true that the law allows promotion from the ranks; but at present the number must not exceed six per annum, and while it might be increased to advantage, it must be remembered that the duties of a modern naval officer require a man of an exceedingly broad range of knowledge, such as can only be gained by a thorough course of study for a period of years at the Annapolis Academy.

In view of the facts given above, it is evident that no measure connected with the defenses of the empire can be brought before the next Congress that will have anything like the urgency of the naval personnel bill.

BRITISH CRITICISM OF AMERICAN RAILROADS.

Discussion of American institutions by fair-minded and competent critics is always valuable and welcome. From time to time we receive visits of inspection from accredited experts of other countries, who are given every facility to examine our social and industrial institutions. In 1901 Col. W. B. Constable, the Manager of the Eastern Bengal State Railway in India, was sent over to examine the working of our railroads, and his report, which is characterized by well considered criticism, shows that he was well qualified for the task. His tour of inspection included a great many of our leading railroads and an investigation of their shops, rolling stock, track, stations and systems of signaling. With regard to the track, he thinks that our method of laying rails with broken joints, that is to say, with the joint of one rail immediately opposite the center of the other rail, is peculiar to this country; and while we differ from the rest of the world in this respect, he presumes that we have the best of reasons for the practice. He commends our use of from 2,500 to 3,050 cross-ties per mile of track, as compared with the 1,760 to 2,000 ties per mile used in India and England, since it cannot be questioned that the greater number of ties gives a smoother and stronger track. He also commends our shorter and narrower platforms as being cheaper than those used in India, and he would imitate us in permitting level crossings at small stations, claiming that the Indian practice of requiring overhead bridges at the small stations is too costly. On this last point we must admit that we can scarcely agree with his findings; for the large number of people killed annually at railroad crossings in this country suggests surely that more overhead bridges and fewer grade crossings, as in India, would be to the public advantage. He considers with much reason that our fencing is wretchedly poor; and that while the roadbed is often indifferent, the lavish use of cross-ties, as above referred to, compensates its defects, while the great length and weight of our cars conduces to their comfortable riding compared with the roughness of the smaller cars on Indian roads. The great Southern Terminal station of Boston is considered by Col. Constable to be the finest station in the world, a conclusion in which we think he is perfectly correct. He is of the opinion that pneumatic or electric power interlocking will take the place of manual interlocking at large stations, more particularly because of the reduction in plant and the necessary staff of operators. He was very favorably impressed by the use of automatic block signals in this country, and he has no doubt that English roads will ultimately adopt some form of automatic system, which will also be found indispensable in such large cities as Calcutta, Bengal and Madras.

To the New York Central Road he gives credit for having the best railroad joints that he found anywhere in the United States, and the criticism is well made. The New York Central have always used three-tie joints, that is joints with a tie near the end of each rail, and an additional tie immediately below the joint. This ample bearing, combined with the use of long six-bolt angle bars, has given a joint which, when it is kept in good condition, is so smooth as to be inaudible to passengers riding on the cars. It is curious to note that the critic was struck, as many everyday passengers have been, with the difference between the joints on the New York Central and on the New Haven lines. On the latter road short four-bolt angle-bars are used with a single tie at each rail end, and none immediately beneath the joint. As a consequence the joints are generally low, a point which did not escape the eye of this critic. He was favorably impressed with the American rails, which he characterizes as being heavy, tough, stiff, of great tensile strength, and with a broad head. He himself has always been an advocate of the heavy rail section, and he considers that he found a strong indorsement of his views in the good results obtained from their use in this country.

WHERE OUR MANUFACTURES GO.

Those of us who are watching the present wonderful commercial expansion of their country will be interested to learn what countries our manufactures are sent to and in what proportions. During the year 1901, 62 per cent of our exported manufactures were carried to Europe, and 23 per cent to North America, these two countries together taking three-quarters of our exports. Of the balance, 8.2 per cent went to Asia; 7 per cent to Australia, New Zealand, etc.; 6 per cent to South America, and something less than 3 per cent to Africa. The total value of the exports to Europe was $215,000,000, and to North America, outside of the United States, $96,000,000, the exports to other countries being in the proportions as given above. An analysis of the nature of these exports shows that the largest item of European exports was $44,000,000 worth of iron and steel manufactures. It will be a matter of surprise to learn that almost an equal amount of copper manufactures was exported, the total value being about $41,500,000, while the exports of refined or manufactured oil were not far behind, the total being $40,736,000. The values of the other principal exports were, of leather and manufactured leather goods, $21,000,000; agricultural implements, $10,500,000; drugs and dyes, $6,741,000; the balance of the total exports being made up of paraffine, wood manufactures, scientific instruments, etc., in decreasing amounts. The largest item in the exports to North America was iron and steel, which were sent out to the value of $43,518,000; the next items in point of importance being cotton manufactures, $6,628,000; and cars and carriages, $3,577,000. To South America, the largest exports were of iron and steel to the value of $8,750,000; to Asia of refined or manufactured oils to the value of $12,442,000; while to Oceania the principal manufactures exported were iron and steel valued at $8,872,000. Historically, it is interesting to note that in 1790 the total exports of manufactures from this country amounted to only a little over $1,000,000 and formed only 6 per cent of the total exports; in the decade 1791-1800 exports of manufactures averaged only about $2,000,000 per annum, and they never reached as much as $10,000,000 per annum prior to the year 1840. In the year 1850 exports of manufactures had reached a total of $17,500,000; in 1860 they reached the $40,000,000 mark, and in 1870 the total stood at $68,280,000. It was not until 1877 that they passed the $100,000,000 line, the total for the year being $122,577,000. Nineteen years later, in 1896, the total value passed the $200,000,000 mark and had risen to $223,571,000. In 1899 the total was $339,600,000 and during the present century the exportation of manufactures has constantly exceeded $400,000,000 per annum.

RAILROAD EXPANSION IN SOUTH AFRICA.

Following the declaration of peace in South Africa, and the return of the country to the normal order of things, a determined effort is to be made to develop the industries of the country, in order to render South Africa a formidable competitor in the great struggle for the world's trade. Primarily, a comprehensive extension of railroads is to be carried out, since it is only by the construction of a network of railroads throughout the country that its resources can be developed to the utmost, and its produce dispatched expeditiously, easily, and cheaply to the coast for shipment to foreign markets. At present, there is a tendency toward competition between the various railroads for the traffic, but it is desired to bring the various railroads together into one homogeneous whole, stop ruinous inter-competition, and establish a fair tariff for the conveyance of freight.

There is also another very great difficulty against which the railroads have to contend—the present unsatisfactory condition and deficiency of labor supply. The far-reaching influences of this problem are exemplified in connection with the Natal-Harrismith railroad either via Reitz or Wilge River, to some point on the Central South African Railroad's main line near Vereeniging. This railroad was extended for military purposes during the war for eighteen miles beyond Harrismith to Elands River, and surveys for the rest of the route are to be carried out. These surveys will be completed in about six months. The advantage to Natal of this connection will be very great. It will save about one hundred miles of uphill haulage, and will shorten the route from Durban to Johannesburg by over forty miles. It will also shorten the distance by rail from Durban to Cape Town considerably. But unless a solution is found to the native labor difficulty, or some means are adopted to provide skilled white labor, this railroad, in common with many others equally important, will be a long time in course of construction, even if work is immediately commenced upon it. The present railroad extensions scheme comprises the surveys for the following lines in the Transvaal:

1. A track from Springs over the High Veldt to a junction with the main railroad near Machadodorp.
2. The remaining unsurveyed portion of the railroad from Vereeniging to Johannesburg (direct route).
3. A track from Krugersdorp to Rustenburg.

In the Orange River Colony the projected railroads are:

1. A track from the present terminus at Elands River, near Harrismith via Reitz, or the Wilge River, to Vereeniging.

2. A road from the present terminus of surveys on the Bloemfontein-Ladybrand Railroad (Thaba Nchu), through Modderpoort to Ficksburg.

3. A track from Fauresmith to Koffyfontein.

The former surveys of the roads Harrismith-Bethlehem-Heilbron, Belfast-Lydenburg, and Pretoria to Rustenburg are already in hand. The survey from Fauresmith to Koffyfontein is an extension of the existing railroad from Springfontein to Fauresmith on which the track has not yet been laid.

The branch from Machadodorp to Ermelo, which was under construction by a company before the war, is to be completed by the company at its convenience. The earthworks were well advanced when work had to be stopped.

There are numerous other extensions well in hand, but in several instances, where the roads were commenced before the war broke out, and conflict with the latest arrangements or existing roads, they are in a state of chaos. This is notably the case with the Silati Railroad. The extension from Pietersburg toward Rhodesia via Tuli, is liable to be objected to by both the Cape and Rhodesian Railroads, and unless union of the schemes is effected such an extension would probably divert much traffic from the two last named. It is not considered advisable to construct any such roads through districts already adequately supplied with railroad facilities. The government is going to relay the whole of the main railroad through the Orange River Colony with 80-pound metal rails to allow the use of heavier and more powerful locomotives, and thus increase the train loads. A comprehensive system of light railroads connecting the main road to outlying districts is to be carried out to facilitate transport. A branch from Bloemfontein to Thaba Nchu will probably be completed in about six weeks; and it is the intention eventually to continue it to Ficksburg.

The new direct line from Vereeniging to Langlaagte or the West Rand, upon which the heaviest types of locomotives are to be used to enable heavy loads to be drawn, will probably be one of the first to be completed as soon as labor is available. All the embankments, etc., were constructed during the war, except about ten miles near the center, in a district then occupied by the enemy. The survey of these ten miles is to be proceeded with at once. In connection with this direct railroad the "coal road" along the reef will be completed, and also the sidings into the mines, involving the laying of some forty-five miles of track, chiefly in the sidings.

THE THREE HUNDREDTH ANNIVERSARY OF OXFORD'S BODLEIAN LIBRARY.

On October 8 and 9 the University of Oxford celebrated the three hundredth anniversary of its famous Bodleian. When it was first opened, November 8, 1602, in the building erected in 1487-8 over the Divinity School, by Humphrey, Duke of Gloucester, the library contained only 2,000 books. The Bodleian had its comparatively humble origin in the bequest by Bishop Cobham, of Worcester, of some books, for which was built in the later years of the fourteenth century a little room in an annex to St. Mary's Church. About a hundred years later, Humphrey, of Gloucester, who seems to have been a kind of Mæcenas, gave books and manuscripts to the university, which were only too zealously destroyed by the fanatical anti-Popery commissioners of Edward VI.

Sir Thomas Bodley, after whom the library was named, was born in Exeter in 1545. His father, John Bodley, on Mary's accession, fled to Geneva, where his son attended lectures on Hebrew and Greek, as well as those of Beza and Calvin on divinity. After the death of Mary the family returned to England and Thomas entered Magdalen College, Oxford, in 1563. He was elected Fellow of Merton. Entering the diplomatic service, Bodley became Elizabeth's Minister to the Hague. Disappointed by Burghley he retired into private life, resolving, as he tells us, to set up his staff at the library door in Oxford, and to restore that place, then in a pitiful state of ruin, to the public use of students. In order to accomplish this purpose he began the establishment of a library in 1598, using as a nucleus the few books of Duke Humphrey and Roger Lisle which had escaped the ravages of Edward VI.'s commissioners. In four years Bodley collected and catalogued about 2,000 volumes. Walter Raleigh and other friends aided him. Bodley induced the Stationers' Company, in 1610, to send to Oxford a copy of every work which they printed. Out of his own pocket he paid for a third story to the "Schools;" but he never lived to see the fulfillment of his labors. In his will he provided for the endowment and maintenance of the library.

In 1639 the Abbot of Osney, Thomas Huskenorton, reduced the public schools into one building. Archbishop Laud, John Selden, the Earl of Pembroke and Sir Kenelm Digby ranked among the earlier benefactors of the library. To the contents of the Bodleian have been added, during the last three centuries, the statues given in 1755 by the Countess Dowager of Pomfret, antique marbles presented by Selden's executors, and the inscribed marbles gathered by Thomas, Earl of Arundel, at his house in the Strand, London, which his grandson, Thomas, Duke of Norfolk, persuaded by Evelyn, gave in 1667 to the University. Of interest are also the Gough (topography and MSS., 1799), Ballard, Wood, Rawlinson, Malone, Douce and Sutherland collections. The auctarium on the chief stairway is reserved for the choicest books and illuminated MSS. Many rare portraits are to be found in the old library. The picture gallery contains Fouquet's models of ancient buildings; Allan Ramsay's portrait of Flora Macdonald, painted in 1749; portraits of Mary Queen of Scots, and Sir Kenelm Digby; some splendid busts, and the brass statue executed by Hubert Le Sœur from designs by Rubens of William, Earl of Pembroke. In an apartment known as the "Old School," may be found the Hope collection of 200,000 books and engraved portraits. So largely has the number of volumes increased that the printed books alone amount to nearly 600,000 in number, while the manuscripts number about 28,000, and so overwhelming has been the overflow that the contents of the adjacent Radcliffe were transferred forty years ago to the University museum in order to make room. The modern books have been removed into the Radcliffe, which is now called the "Camera Bodleiana."

AN EXAMPLE OF WIRELESS TELEGRAPHY'S EFFICIENCY.

A very adequate idea of the utility of the Marconi wireless telegraphic invention, and the wide and beneficial influence it will exercise from a commercial point of view, in connection with vessels engaged in the transatlantic traffic, was afforded recently by the log of the Cunard liner "Campania" on a round voyage from Liverpool to New York and back. The "Campania" left Liverpool at 4:30 P. M. on Saturday, August 30, and remained in communication until 6:10 P. M. with the same company's steamer "Ivernia," also fitted with the Marconi system, which was lying in the Huskisson Dock, Liverpool. From 7:05 to 8 P. M. she was in communication with the homeward-bound "Umbria" in the Mersey Channel. At 8:30 Holyhead was signaled, followed by Rosslere station at the southeast corner of Ireland until 3 A. M. on Sunday, August 31. Passengers and mails were embarked at Queenstown, and the ship sailed at 10:15 A. M. on Sunday, August 31. She was then in communication with Crookhaven from 11:40 A. M. until 3:15 P. M. At 1:35 A. M. on September 3 she came into communication with the homeward-bound "Lucania" and exchanged messages with her for some time. At 4:45 P. M. on September 5 she signaled Nantucket lightship, and continued in communication until 8:30 P. M. At 11:30 P. M. Sagaponack station replied to her call, and continued talking until 1:40 A. M. the next day, when she was abreast of Fire Island, distant about 60 miles, and the new station at Babylon, north of Fire Island, came into communication about the same time as Sagaponack ceased. She kept in touch with the latter until Sandy Hook lightship was passed at 3:18 A. M.

On the homeward passage the "Campania" left New York on September 13 and was in communication with the "Umbria," which was just arriving at that port between quarantine and dock. She then got in touch with the Babylon station at 7:40 P. M., and continued until 1:40 P. M. Then Sagaponack station followed. She next communicated with the inward-bound "Lucania" on September 16 at 11 P. M. and continued until 1:40 A. M. on the following day. On the 17th she conversed with the Atlantic Transport vessel "Minnehaha" for some hours. The Cunard homeward-bound "Saxonia" was signaled at 2:50 P. M. on the 18th, when she was 36 miles ahead of the "Campania," and the two steamers were in communication until the evening, when the "Saxonia" was 100 miles astern. Crookhaven was signaled on the 19th at 8:45 A. M. and conversation was maintained until 11:40 A. M. The "Campania" arrived at Queenstown at 12:50 A. M. on the same day.

From this log it will be seen that it is practically possible to cross the Atlantic, and to remain in communication with the land all the way across via various ships, which can act as retransmitting stations. If all the vessels plying between this country and Europe were similarly equipped with the Marconi apparatus, it would be possible for a man to remain *au courant* with home or the commercial world the whole of the five or six days' sea passage.

SUCCESSFUL TEST OF A TOWER ELEVATOR.

An experimental four-hundred foot drop of the Philadelphia City Hall tower elevator recently proved that the safety air cushion device installed will probably prevent any serious accident. Within the short distance of 84 feet the speed of the car was reduced from 2½ miles a minute to zero. In the car were placed eggs, delicate incandescent light bulbs and rats. When the car reached the bottom most of the eggs were found in good condition, the incandescent light bulbs were intact and the rats alive and well. The trip was made directly under the Penn statue, 372 feet 9 inches above the bottom of the shaft. The particular safety device used is the Ellithorpe safety air cushion.

SCIENCE NOTES.

In order to encourage the study of science among women, the Association for Promoting Scientific Research Among Women has offered two prizes of $1000 each for the best papers prepared by women. One is for the best work based on independent laboratory research in biological, chemical or physical science, and the other on any scientific study. The chairman of the prize committee is Miss Ellen H. Richards, of the Massachusetts Institute of Technology, Boston.

The United States Coast and Geodetic Survey has published a very handsome and serviceable map showing the lines of equal magnetic declination and of equal annual change in the United States for 1902. The lines of equal magnetic declination or isogonic lines are given for every degree and are based on a new observation up to July 1, 1902. The lines of equal annual change of the magnetic declination pass through all the lines where the annual change is of the same amount.

A woful cry is going up from the representatives of all the ologies, and one hears nothing but a doleful wail about shrinking incomes and curtailing of operations. Take the Palestine exploration fund, for example. Here the secretary laments a decrease of the society's income by nearly one-third within the past three or four years, and he attributes this in a great part to the war, the absence of so many of the most influential and wealthy officers and the corresponding anxiety of their families.

It is generally believed that the bite of sea serpents, or hydrophids, is not dangerous, but this is not so, and cases of death from this cause have been observed by Comtor in Japan, Fayrer in India, and Forné in New Caledonia. M. Kermorgant has published some new observations in the Annales d'Hygiene et de Medecine Coloniales. The geographical distribution of the sea serpents is very extensive, embracing a marine zone which is bounded on one side by the coasts of Asia and Africa and on the other by the west coast of Central America; Australia is included in this region. The species are numerous and they are all dangerous. These include the *Hydrophis nigra* and *H. nigrocyneta*, of the Indian Ocean and the seas of China; the *H. chloris*, of the Indian Ocean, also the *H. cyanocyneta*, as well as the *Pelamys bicolor* of the Australian coast. If the effects of their bite have not been more often pointed out it is because they are not mortal in a great number of cases. In many of the colonies of New Caledonia these serpents are found in abundance, and the opinion is so general that they are harmless that the snake charmers use them in their performances. In fact, they bite but rarely and with difficulty owing to the smallness of their mouth, and the dangerous effects are not frequent as they have only very small venom-glands and minute fangs. The head, which is small, is scarcely to be distinguished from the body, while the tail is flattened in the form of an oar. The length often exceeds three feet. A rat, when bitten by one of these serpents, dies in four or five minutes.

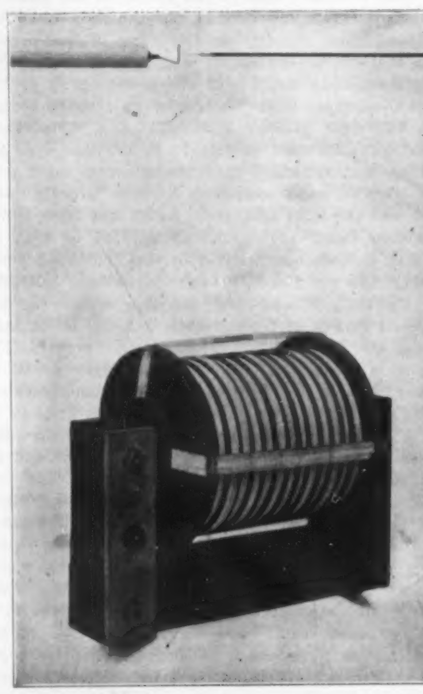
H. Rieder reports a continuation of the experiments begun by him in 1898 relative to bactericidal power of Röntgen rays. The bactericidal power of the Röntgen rays was tested against the cholera spirillum, the bacillus prodigiosus and the colon bacillus. The micro-organisms were inoculated into gelatine or agar and exposed to the action of the rays in Petri dishes, the covers being removed. After twenty to thirty minutes' continuous exposure to the rays many of the bacteria were killed, and multiplication ceased in nearly all. In every series of experiments, however, a few of the individual bacteria were not affected. Experiments have shown that the bactericidal power of the rays is not due to the fluorescent light, heat, ozone or electricity. So far as is known the culture media are not altered by the rays or made unsuitable for the growth of bacteria. Gelatine is never liquefied. It is not, however, to be assumed on the basis of the above experiments that the Röntgen rays possess any bactericidal action upon bacteria when present in the animal body. The evidence from animal experimentation is against such a supposition. As a rule, animals inoculated with pathogenic bacteria and exposed to the rays die sooner than similarly inoculated animals which are not thus exposed. It is not to be denied that in the human subject certain infectious diseases, particularly those of the skin, may be successfully treated by the Röntgen rays, but it does not seem probable, at the present time that such success is due to bactericidal action.

THE COMMERCIAL UTILIZATION OF ATMOSPHERIC ELEMENTS.

In order to properly introduce this subject to our readers we must turn back to the fall of 1898, when the attention of the world was directed to a serious problem. Sir William Crookes in his inaugural address before the British Association discussed the probable future shortage of wheat as a result of the failing supply of nitrogenous fertilizers. He pointed out that guano beds which had for a long time formed the principal supply of nitrogenous manures were almost exhausted, and practically the only compound of nitrogen then available for use as fertilizer was found in the nitrate of soda deposits which cover a limited area in the north of Chile. As a possible solution of this grave question, Sir William Crookes suggested the fixation of atmospheric nitrogen by means of electricity, and predicted that for such an enterprise Niagara would prove the best location, because of the low cost of electricity at that place. A short time after this two American inventors, Mr. Charles S. Bradley and Mr. D. R. Lovejoy, quietly began a series of experiments. Seemingly the only thing necessary was to produce a series of powerful disruptive discharges which would burn the air and produce the required gases, but the problem did not prove to be so simple. Difficulties were met from the beginning. A complete history of the efforts and failures of these two inventors would be a long story, but suffice it to say that disruptive discharges were found to give very poor results, and it was only when electric arcs were tried that the subject gave promise of success.

APPARATUS FOR OBTAINING NITROGENOUS COMPOUNDS BY BURNING AIR WITH ELECTRIC ARCS.

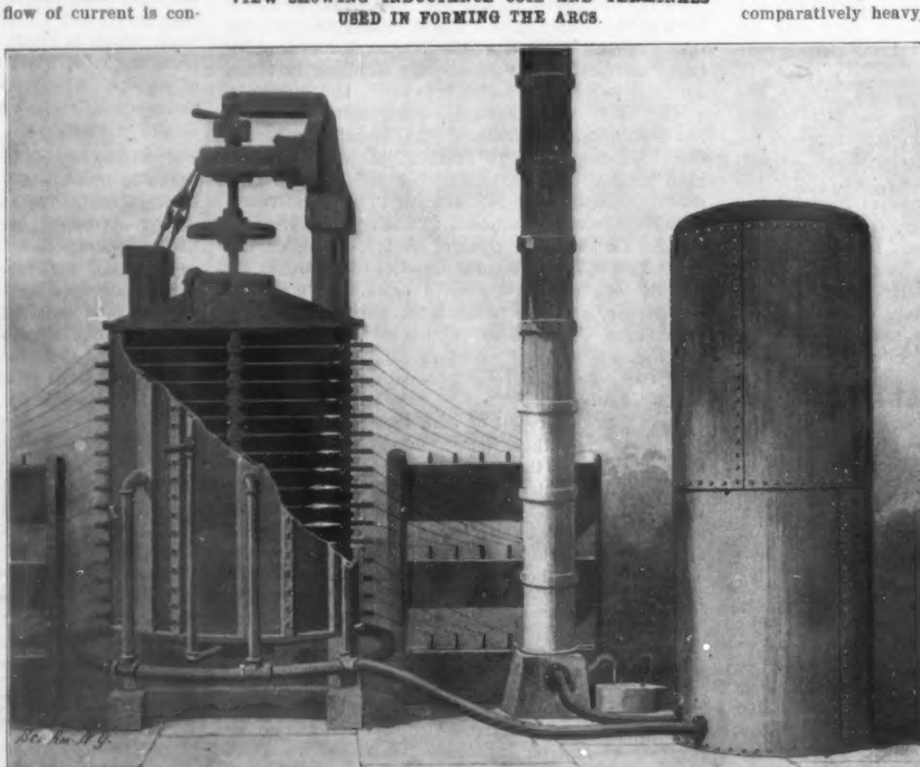
We show herewith several views of the machine which is the culmination of these experiments. Briefly stated, the apparatus comprises an air chamber in which electric arcs are formed between series of stationary terminals and series of revolving wire fingers. The oxygen and nitrogen of the air in the chamber are caused to enter into chemical combination by these arcs, and the resulting gases are drawn off to an absorption tower, where they are combined with various substances to form the required nitrates. Contrary to previous suppositions, the inventors found in the course of their experiments that alternating currents give unsatisfactory results, and so a large direct-current dynamo generating 10,000 volts was procured. This machine was slightly altered to comply with certain special requirements; for instance, it was found that the best work was done by a very slender arc of great length. It was, therefore, necessary to reduce the amperage to a minimum. The positive and negative poles of the dynamo are respectively connected in multiple with the revolving and stationary terminals. The flow of current is controlled by means of an inductance coil in each of the arc circuits, these inductance coils serving to subdivide the current from the dynamo. One of our illustrations shows the form of inductance coils used. The importance of these coils cannot be overestimated, and the greatest care is exercised in their proper adjustment. Each coil comprises 20,000 turns of fine wire and has a self-induction of approximately 150 henries. The coils are submerged in tanks of oil which are arranged in groups radiating from the combustion chamber, the oil being used to insulate the coils. The current in passing through these inductance coils is reduced to any required small value, 0.005 ampere being the amount which is used in this case. The stationary terminals are arranged in the combustion chamber in six vertical rows passing through insulating bushings. Wires from these terminals may be seen leading to the inductance coils. The revolving terminals consist of wire arms extending radially from a center shaft. These wire arms or fingers correspond in number to the stationary terminals and are symmetrically grouped about the shaft in six spirals of one sixth of a turn each. By reason of this arrangement the contacts are made successively in series of six at a time. The revolving shaft is driven by a small motor at the top of the machine, at a speed of 500 revolutions a minute. Thus it will be seen that each finger makes 3,000 arcs a minute. Immediately to the left of each row of stationary terminals is a recess or channel formed in the wall of the chamber. A metal deflector covers the inner face of each channel, leaving a small slit through which the gases resulting from combustion of the air are admitted into the channels and led away into the absorption tower. Fresh air is supplied to the chamber through pipes opening therein at the upper and lower bearings of the central shaft. The purpose of this arrangement is to afford an even distribution of the air and incidentally to cool off the bearings of the shaft. The air before being introduced into the chamber must be thoroughly dry, otherwise the moisture it contains is liable to unite with the gases while still in the combustion chamber to form nitric acid, which would attack the metal parts, break down the insulation, and do considerable damage to the machine. At present the moisture is absorbed by passing the air through calcium chloride, but in the new plant which is now being built desiccation of the air will be accomplished by refrigeration.



VIEW SHOWING INDUCTANCE COIL AND TERMINALS USED IN FORMING THE ARCS.

In the side wall of the combustion chamber are a number of "bull's eyes," or glass-covered openings, through which the observer may watch the arcs. As each wire finger reaches a stationary terminal a small blue spark jumps across the slight intervening air gap, and a flow of electricity ensues, forming an arc which is rapidly drawn out by the rotating terminal to a length of seven or eight inches before breaking. The nature of the arcs is governed by the inductance coils, which at first resist the current and later add their own energy to prolong the arc. When the machine is first started, the arcs give a comparatively white light, but this gradually changes to a reddish hue as the gases are formed. Intense heat is, of course, produced, and it is necessary to tip the terminals with platinum in order to prevent them from wasting away. The purpose of leaving a slight air gap between the negative and positive terminals is to prevent frictional wear, which would require constant readjustment of the parts.

Possibly some of our readers may have noticed that the stationary negative terminal is provided with a comparatively heavy platinum wire, while a very fine wire forms the tip of the positive terminal. This is due to a very curious phenomenon. We all know that the positive carbon in the ordinary arc light is more intensely heated than the negative pencil. It was found that at a certain small value of the current this difference of temperature was reversed, so that the negative became hotter than the positive. This phenomenon was first noticed by Prof. W. H. Freedman, of the University of Vermont. The air as it is burned by the electric arcs forms nitric oxide (NO), which immediately combines with another portion of oxygen and forms nitrous anhydride (N_2O_3). The chemical actions are usually slow, and in order to permit the combination to properly take place the gases are first passed through a large chamber, shown at the right in our illustration, before being drawn up into the absorption tower. The absorption tower is built up of a number of tile-pipe sec-



Combustion chamber. Absorption tower. Intermediate receiving chamber.

GENERAL VIEW OF THE APPARATUS—COMBUSTION CHAMBER PARTLY BROKEN TO SHOW INTERIOR DETAILS.

tions, and in the formation of nitric acid it is filled with coke. Through this the gases are slowly borne by means of an exhaust fan at the top of the tower, and are brought into contact with water, which trickles down through the coke. Nitric acid (HNO_3) is then formed by the following reactions when the gases are warm: $3\ N_2O_3 + H_2O = 2HNO_3 + 4NO$. The latter product unites immediately with oxygen as follows: $NO + O = NO_2$. This in turn unites with water and forms another portion of nitric acid: $2\ NO_2 + H_2O = HNO_3 + HNO_2$, while the latter product breaks up according to the following equation: $3\ HNO_2 = HNO_3 + 2\ NO + H_2O$. The two molecules of nitric oxide (NO) will then repeat the cycle, beginning at the second equation. If the gases are cold a more simple reaction takes place, and nitrous acid is formed as follows: $N_2O_3 + H_2O = 2\ HNO_2$. This, however, is a very unstable acid and at ordinary temperatures decomposes, as in the fourth equation above, to form nitric acid, nitric oxide and water.

In the production of fertilizer the gases are combined with lime to form calcium nitrate. This is a far better fertilizer than sodium nitrate or Chile saltpeter now on the market, first because there is danger of injury to plant life when the latter is used too freely, owing to the presence of soda, which burns the roots of the plants, and second because lime (which the soil needs) is liberated from the calcium nitrate, instead of soda, which is the result of the decomposition of nitrate of soda (which the soil does not need and which is positively injurious). The cost of producing calcium nitrate according to the process described is less than one-half the present cost of sodium nitrate. In their endeavor to reduce the cost of production to a minimum, Messrs. Bradley and Lovejoy found that the output of the machine is governed by the following three considerations: First, the amount of electric current, which as previously stated, gave the best results at between 0.001 and 0.01 ampere; second, rate of air current passing into the chamber, since too rapid a flow would result in the chemical combination of only a small portion of nitrogen and oxygen of the air, while too slow a flow would permit the gases to pass a second time under the influence of the arcs and dissociate the compounds previously formed; third, the amount of oxygen in the air, the best results being obtained when the gaseous mixture is composed of approximately equal portions of oxygen and nitrogen. Notwithstanding the fact that the machine is already a commercial success, experiments have not ceased. The inventors are thoroughly testing all details, and are busy working along new lines which are constantly presenting themselves.

The first Pacific third rail system was opened in August. The road extends between Riverside and Van Asselt, California, for a distance of about six miles. Throughout the trial run a speed of fifty miles an hour was made.

NEW YORK-BOSTON AUTOMOBILE RELIABILITY TEST —THE FIRST DAY'S TRIP.

Under a cloudless sky and in the bracing air of a fine October morning, seventy-five of the seventy-eight automobiles entered in the Reliability Test started north on Fifth Avenue from Fifty-ninth Street in this city at 9 o'clock, for New Haven, Conn. The vehicles began the journey at thirty-second intervals by the official timekeepers, stationed at Fifty-eighth Street, and soon formed quite a procession as far as the eye could reach. The operators and observers as a rule had their eyes protected by goggles, while many of the experienced chauffeurs were dressed in the typical dust, dirt and rain-proof black leather suits.

MOUNTING BYRAM HILL, GREENWICH, CONN.--SIXTEEN PER CENT GRADE.

The route followed was north in Fifth, thence west to Seventh Avenue and via Jerome Avenue to Fordham, then east across to the Sound Shore Road, northeasterly into New Rochelle. From here the old Boston Post Road was followed through the various cities and towns to New Haven, Conn. The first forty-four miles to Norwalk, Conn., where the first control was stationed, were scheduled to be covered in three hours and ten minutes, which constituted an average speed of 14 miles per hour.

The Knox carriage, in which the writer and observer traveled, was one of three of that kind entered in the run. The novel feature of this machine, as illustrated and described in the SCIENTIFIC AMERICAN of March 1, 1902, is an eight horse power air-cooled motor which has numerous heat-radiating pins screwed into the outer wall of the cylinder, upon the head of which a fan, driven by a pulley on the two to one cam-shaft, is constantly blowing. The radiating surface is much greater than that obtained on motors of the flange air-cooled type, while the fan serves to keep the valves and valve springs reasonably cool.

Starting among the foremost of the contestants, two of these machines kept together throughout the whole first day's journey, and all made a perfect record. Not a stop was recorded against them in either of the two stages, and the two that kept together were on time to the minute at the noon and night controls. No bad roads were met with during the entire day's run, though several bad hills were encountered in the vicinity of Greenwich and Norwalk, Conn. Our illustrations give an excellent idea of the train of automobiles mounting the long sixteen per cent grade at Byram Hill, in the town of Greenwich, and the way in which the vehicles were lined up for starting on the second half of the journey at Norwalk. The Knox machines climbed these without perceptible effort, and the low gear was not resorted to in any case till two-thirds of the hill had been traversed. One or two long and rather steep hills, where a good start was obtained, were ascended entirely on the high gear, without once throwing out or "jockeying" the clutch; and on the whole the Knox motor developed fully as much power as any water-cooled motor of its size, and an abundance for propelling its 1,300-pound carriage up the steepest grades. The many advantages and the simplicity of the new system are obvious, and need not be dwelt upon here.

By means of a table giving the times at which the different towns should be reached, it was possible to keep close to an average speed of fourteen miles an hour. It was difficult to hold to this speed, which seemed very slow on the smooth stretches of road, especially when many of the more eager contestants would now and then speed past. We were some minutes ahead of our schedule after passing through Stamford, Conn., and so, in company with many others, we were obliged to "lose time" during the last few miles, in order not to exceed our minimum time limit. We passed about a half dozen cars in trouble from punctured tires throughout the entire morning's run; but there were no genuine breakdowns noted, all the machines arriving at Norwalk. A Packard heavy-weight car had a tire give

LEAVING NORWALK, CONN.—THE FIRST CONTROL STATION.

out a few yards before crossing the line at the noon control. Another car that had tire troubles was the huge locomotive racer of S. T. Davis, Jr. The locomobile gasoline touring car was driven by its designer, Mr. A. L. Riker, and reached both controls on time, without any mishaps. Three White steam stanhopes and two White delivery wagons arrived safely at the finish, and all the well-known firms, such as the Winton, Haynes-Apperson and Oldsmobile Company, were represented by two or more of their cars. Among the new machines that reached New Haven successfully were the Rambler, the Stevens, Duryea, the Fredonia, the Elmore (driven by a two-cycle engine) and the Autocar tonneau. A combination gasoline-electric car entered by Knight Keftel, owing to a defective water circulation in its gasoline engine, became overheated and did not reach Norwalk for three and a half hours after the others. The battery was kept charged en route by the gasoline motor and generator. The contesting carriages were mostly of the gasoline and steam types only. The first vehicle to reach the New Haven control was a De Dion run by Kenneth A. Skinner. Seventy-two vehicles out of seventy-five starting from New York reached New Haven. Each observer is provided with a specially-arranged note book having pages of sectional maps explaining the route and other pages for noting mishaps and delays that may occur. The contest began on Thursday morning, October 9th, and occupied three days from New York to Boston, resting there over Sunday. The return to New York was made on Monday, October 13th, taking three days and was concluded in New York on the 15th inst. The distance traveled was 488 miles.

Reports of the second day's run, October 10th, from New Haven, Conn., to Springfield, Mass, sixty-nine miles, state that out of seventy-three leaving New Haven seventy-one reached Springfield. The Knox machine, on which the writer rode, broke its crank shaft before reaching Hartford and a Haynes-Apperson machine in running rapidly into a sand ditch at one side of the road in avoiding a rear collision with preceding vehicles broke both front spring hangers, which caused the front of the body to fall on the gear, making a peculiar looking appearance. There were numerous brief delays to other vehicles caused by punctured tires or defective sparking plugs. The first to arrive at Springfield was a Packard, time from New Haven being 3 hours, 11 minutes, 45 seconds. In the evening a banquet was given the travelers by the Knox Vehicle Co. at the Cooley House, Springfield. The third day's run from Springfield to Boston on the 11th was successfully completed, sixty-nine machines reaching there on time.

The French Naval Department is constructing a new type of submarine boat, the invention of Lieut. Boulin, commander of the submarine "Triton." This craft is entirely different in its general design from all existing submarine war vessels, inasmuch as it is practically a submersible armorclad. The boat, which is of much greater dimensions than the present submarines, resembles a small cruiser, is propelled exclusively by steam power, and is replete with powerful quick-firing guns. When submerged it is not entirely obscured beneath the water, but the upper portion of its funnel is shown above water, and this, being painted gray, is visible only at short distances. To attack, the boat emerges from the water, launches its torpedo, discharges its guns, and again descends into the water, leaving only its funnel to be fired at, the water forming an excellent protection to the hull, which is built of chrome steel. This vessel is to be constructed at Cherbourg and will cost $400,000.

An attempt is being made in England to revise the standard of weights for commercial purposes. The suggestion is to create new weights of 50 pounds, 25 pounds, or 20 pounds, 10 pounds, and 5 pounds avoirdupois, respectively, to run concurrently with the hundredweight series of weights. The corn, cotton and tobacco trades have adopted the cental system, but it is necessary to make up the cental to use the 56-pound, the 28-pound, the 14-pound and the 21-pound weight. If two sets of weights are used, one based on the hundredweight and the other on the cental, confusion can be avoided by making the new weights, or otherwise plainly distinguishing between the two series of weights. This new system is averred to be imperative in order to accelerate and make British trade easier than it is with the antiquated system of hundredweights, quarters and pounds. The proposal is being enthusiastically supported and there seems every possibility of its coming into vogue.

The new balloon for Mr. Santos-Dumont, the construction of which has been begun, will be 25 meters long by 11 meters in diameter, and will carry two aeronauts and eight passengers.

IMPROVED RAIL-BEARING PLATE.

The increasing weight of our railway freight and passenger trains is presenting new difficulties to civil engineers. The mammoth locomotive of to-day is too heavy for the track construction of yesterday. New devices must be provided for securely holding the rails, for firmly spiking the rails to the ties, and above all for protecting the ties themselves against the crushing pressure to which they are subjected. Neglect in any of these particulars will result in the spreading of the rails and causing accidents of serious proportions. The truth of this statement is proved by the large number of railway accidents due to spreading rails; and, further, the patent records show that the attention of inventors has been, to an increasing degree, directed to the solution of these difficulties.

A device which is adapted to positively hold the rails against sidewise movement and to entirely prevent crushing of the ties has recently been invented by Capt. V. E. McBee, fourth vice-president of the Seaboard Air Line, residing at Norfolk, Va., and who as a civil engineer has had the advantage of a thorough and practical acquaintance with the construction and operation of railways. His invention, which is herewith illustrated, consists of a steel plate of general triangular cross-section, having a prong or spike projection at each end and a boss or heel on the upper surface for engaging the rail flange to prevent spreading. These rail-bearing plates are driven into the ties diagonally to the direction of the track, so as to combine as large a bearing surface as possible for the rail with the most economical use of metal. At the same time this diagonal disposition across the grain of the tie prevents displacement due to splitting of the wood; and the V-shaped under surface of the tie plate being embedded into the tie makes it noiseless and gives additional security against the spreading of the rails. In practice it is found best to alternate the positions of the tie-plate so that the heel or retaining lug abuts alternately against the inner and outer

IMPROVED RAIL-BEARING PLATE.

edges of the rail flanges. One of the serious objections to flat tie plates, now often employed, is their tendency to buckle under the heavy loads they are required to sustain, thus offering practically no protection to the ties, with the result that a large sum must be expended annually to renew ties which have been badly crushed. In this device, however, no buckling is possible, because of the heavy triangular cross-section of the bearing plate. These tie plates because of their simple construction may be very economically manufactured, and the initial expense of equipping a road with them is soon repaid by the increased life of the ties.

Treatment of Roads with Gas Tar.

While roads in the United States have been treated with crude oil to lay the dust and render them compact, in Italy the same end has been attained by using gas tar, and the experiments which have been made seem to be quite successful. M. G. Rimini, the district engineer at Lugo, near Ravenna, has published an account of the application of gas tar to some sections of the public road in that locality. He uses it in two different places on the provincial route near Lugo, where the circulation is very active. The first portion treated measures 40 feet long and 10 feet wide and the second 750 feet long and 13 feet wide. In spite of the prolonged dryness, the results of this treatment have exceeded the expectations, and the surface of the road has become very hard and compact, so that it is difficult to pierce it. There is no dust, and the rainwater flows off without penetrating, and thus there is no mud formed. The color of the soil becomes that of a very dark sand. It is not necessary to treat the whole surface of the road, but only a band in the middle about 12 feet wide. As to the cost of the treatment it is estimated at only $96 per mile. M. Rimini is making observations of the two sections thus treated before applying it on a larger scale.

The Piscicelli Taeggi Electric Post.

News comes from abroad that the Italian government is considering a scheme for the transmission of mail matter by aerial electric railway at a speed of 250 miles an hour. The inventor, Signor Piscicelli Taeggi, has filed an application for a United States patent.

The aerial track over which the mail is to be transmitted consists of four wires which also act as conductors. The top wires will carry the motor or driving wheels, and two lower wires will support the wheels of the mail-boxes. High-tension three-phase current at 3,000 volts, stepped down to a potential of 260 volts, is to be fed to the two top wires and one of the lower wires, for supplying the motors of the mail boxes.

In order that one mail-box may not come within the block occupied by another mail-box, the step-down transformers will be located three or four miles apart. The preceding mail-box will cut off all current on the block immediately behind it. In order to attain this end the second or lower wire is used.

The supporting wheel of the mail-box in the preceding section having completed the circuit in the two lower wires, a current is allowed to pass through the magnetic coils of an automatic circuit-breaker, thereby shutting off the current from the section which it serves. When the mail-box enters the next section-head, the previously cutout section is again well supplied with current, and that immediately behind it rendered inoperative.

A mail-box traveling at the rate of 250 miles an hour acquires an enormous momentum. It therefore becomes a matter of considerable importance to devise means to cut down the speed. The inventor intends to cut off the section in advance of any station from any current by means of station switches, so that the momentum of the mail-boxes will be used only for a certain stretch. In addition, a braking device is employed. The mail-boxes are to be made of aluminium.

Signor Piscicelli Taeggi likewise has devised a system of collecting poles and boxes, as well as an apparatus for stamping the letters with the day, hour and minute of posting. Poles are also provided which act as transformer boxes, as well as supporters of the permanent way.

The letters can be dropped into receptacles, by which they are carried by an electric elevator to the top of the pole, where they are emptied into the mail-boxes.

In criticising this scheme, Mr. William Digby in a recent number of Engineering says that although previous schemes of the same nature have not been altogether successful, nevertheless the remarkable advances made in electricity in recent years may be relied upon to overcome many of the difficulties which will naturally be encountered. He entertains grave doubts, however, whether the speed of 250 miles an hour can become an economic possibility, even if the difficulties of current collection at such speed should be overcome.

How long the aerial system would stand the strain of the mail-boxes' running at immense speed over the positions where the supporting and conducting wires are fixed, is a question that must give electrical engineers pause. Sparking and breakages of trolley wires at such points are among the minor troubles to be expected. When one remembers, too, how much of the vibration in railway trains is due to the spring of the rail ends at the fishplates, it will be recognized that any accentuated form of vibration along an aerial electric railway, with its saggings between insulator and insulator, would be fatal to its success.

The Current Supplement.

The current Supplement, No. 1398, contains as its leading article a fully illustrated account of a novel electric power installation near Butte, Montana. Another electrical article describes the electrolytic manufacture of zinc. Just now the question of using oil as fuel is one that is uppermost in the minds of engineers. For that reason Mr. Edwin L. Orde's exhaustive paper on "Liquid Fuel for Steamships" will prove of unusual interest. Dr. Peter T. Austen, well known as a chemist of rare ability, writes interestingly of the chemical factor in human progress. The launch of the cruiser "Des Moines" is a subject that will appeal to our naval readers. Prof. Dewar terminates his scholarly "History of Cold and the Absolute Zero." The eruptions which have devastated Martinique and St. Vincent, as well as the telluric disturbances which have occurred in other parts of the world, render an article on volcanoes particularly timely.

Capt. Sverdrup, who returned from the Arctic regions soon after Lieut. Peary, narrates his experiences in search of the North Pole.

It is stated that the largest steel plate ever rolled was one recently turned out by the Parkgate Works, England; it is 30 feet long, 10 feet 6 inches wide and seven-eighths of an inch thick.

THE LATEST BRITISH ARMORED CRUISER "GOOD HOPE."

Great interest attaches to the fine armored cruiser which forms the subject of our front page engraving, from the fact that she is the first of a class of extremely fast and powerful armored cruisers which are now under construction for the British government. The vessel is really an improved "Powerful," with all the good points and none of the defects of the "Powerful" and "Terrible," and with certain added excellencies which render her probably the best, all-round fighting ship that has ever been turned out from the English yards.

The "Powerful" and "Terrible," launched in 1895, were at that time by far the largest and swiftest cruisers afloat. They had the defect, now well recognized, that they depended for protection entirely upon an armored deck, no vertical side armor whatever being provided; while their armament was a weak one relatively to the great displacement of 14,200 tons. They showed on trial a speed respectively of 22.4 and 22.1 knots an hour. Their best feature was their enormous coal capacity, 1,500 tons normal, and 3,000 tons bunker capacity. The "Good Hope" and her sister vessels, the "Drake," "King Alfred" and "Leviathan," have practically the same dimensions, viz.: Length, 500 feet; beam, 71 feet; draft, 26 feet, and displacement, 14,100 tons. They have, however, a belt of side armor of Krupp steel which is nearly 400 feet in length, extending from the bow aft. For 280 feet of this length the belt is 11 feet 6 inches broad, and from 6 to 4 inches in thickness. At the forward end the belt increases in width to 24 feet, the thickness being reduced to 2 inches. At the after ends of the belt there extends from side to side a bulkhead of 5-inch steel, the after 10F feet of the ship, though it is without vertical plating, being protected by a 2½-inch deck, which shelters the steering gear and magazines from shell fire. To the vertical side armor protection there is added two protective decks, the upper one 1½ inches in thickness, the lower one 1 inch in thickness.

As compared with the "Powerful," the "Good Hope" has about 1 knot more speed, to attain which the indicated horse power, as named in the contract, has been raised from 25,000 to 30,000, and, unlike the earlier ships, the "Good Hope" more than fulfilled the expectation of her designers; for on an eight-hour full power, steam-trial in the English Channel, she maintained an average speed, as a mean of five runs, ot 23.05 knots per hour, the mean collective indicated horse power beng 31,071.

In point of armament the "Good Hope" is, in general, similar to the "Powerful," with the important exception that she carries four more of the effective 6-inch rapid-fire guns, her total armament being as follows: Two 9.2-inch guns mounted one forward and one aft on the upper deck and protected by a 6-inch shield and barbettes. Sixteen 6-inch rapid-fire guns of the new Vickers' type carried in eight, two-storied armored casemates; twelve 3-inch rapid-fire guns, besides several smaller rapid-firers distributed on the bridges and superstructures. The coal supply is generous, consisting of 1,250 tons normal and a full bunker capacity of 2,500 tons.

It is interesting to compare this cruiser with our own armored cruisers of the "West Virginia" type, which on a displacement of 420 tons less have the same thickness of armor protection except the deck, which is about an inch and a half heavier; one knot less speed; about 500 tons less coal capacity, but which carry a somewhat heavier armament, consisting of four 8-inch, fourteen 6-inch, eighteen 3-inch and twelve 3-pounders, besides several lighter rapid-fire guns. The two new armored cruisers which are to be laid down for our navy this year and are as yet, we believe, unnamed, are considerably more powerful than the "Good Hope." They are of 14,500 tons displacement, 22 knots speed and will carry a complete belt which, with the shield and barbette protection of the guns, will be considerably heavier than that on the "Good Hope." The armament, moreover, will be much more powerful, including four 10-inch guns carried in pairs in two barbettes, one forward and one aft, on its upper deck, and sixteen 6-inch guns, carried behind what will probably be a complete wall of side armor, extending from the belt to the upper deck. Added to these will be over twenty of the effective little 3-inch rapid-fire guns. The normal coal supply will be 900 tons, and the total bunker capacity 2,000 tons. So powerful will be these new cruisers that they may well be included in the battleship class, since many of the foreign battleships carry 10-inch guns in their main barbettes and the latest battleships of the German navy have nothing heavier aboard than the 9.45 inch gun. Altogether these new cruisers of our navy promise to be the most effective fighting ships yet turned out by our designers, in which respect they will hold the same position in our navy as is held in the British navy by the fine vessels of the "Good Hope" class. It should be mentioned in closing that this vessel was presented to the British government by Cape Colony, and hence its name. We are indebted to the builders, the Fairfield Company, of Glasgow, for the illustrations of the ship and engines.

Automobile News.

After five days' trial a jury in the United States Circuit Court on October 7 awarded $12,070 damages to Joseph B. Hughes, of New York, in his suit against Felix Warburg. Mr. Hughes collected damages for injuries sustained by the running away of his horses, which were frightened by Mr. Warburg's automobile at Seabright, N. J. One of the horses was killed and Mr. Hughes permanently injured. Mr. Warburg himself was not in the automobile at the time of the accident.

In one of the leading English periodicals Mr. B. H. Thwaite, C. E., projects an automobile highway from London through the center of England to Carlisle, and thence to Glasgow, Edinburgh and Inverness. The road would have a foundation of concrete and a surface of specially hard creosoted wood blocks with asphalt joints, the surface curvature being sufficient for thorough and rapid drainage. Its central portion would be used exclusively by motor cars, and there would also be side paths for bicyclists. Mr. W. K. Vanderbilt, Jr., is authority for the statement that a similar road is soon to be built in this country from Long Island City to Roslyn, a distance of twenty miles. This road will be entirely on private ground, and will be designed for speeding purposes mainly.

The many accidents recently from fast speeding in France have caused Mons. E. Hospitalier to give, in La Locomotion, some interesting facts as to the inertia of a 2,000-pound automobile traveling at the rate of 75 miles an hour, and the braking power required to stop it. Calculation shows the inertia of the vehicle to be no less than 60,000 kilogramme-meters, or the same that it would have if it fell a distance of 196 feet, the height of the towers of Notre Dame Cathedral. This energy is equivalent to that of a complete train on the Paris underground railway, traveling at its highest speed of 21¼ miles an hour. When a brake is applied capable of a resisting effort of 551 pounds per ton at the rim of the wheels, the retarding power of this brake is, during the first instants, equivalent to 113 horse power. The mean power developed by the brakes while they are applied reaches nearly 60 horse power. And all this terrific strain is transmitted through the frail pneumatic! The wonder is that the tires stand up as well as they do, and that accidents caused by their bursting are, comparatively, so few and far between.

One of the great troubles that automobilists have to contend with is loose nuts on their machines. Mr. Vincent C. Bryce, an experienced mechanic, patented some two years ago a special form of lock nut in which are combined the principles of the lever, the screw and the wedge. The nut is in two parts, an inner tapered core that screws on the bolt and an outer shell that fits over the inner core. The two pieces fit together and form one nut, which can be screwed in place or unscrewed as easily as an ordinary nut, but will never work loose. The nut has been tried on some of the Pennsylvania Railroad locomotives for fastening connecting rods, and has proved an unqualified success. We have also tested a number of them on a gasoline automobile, and found them all that they are claimed to be, and a boon to all chauffeurs. The Columbia Lock Nut Company, of Bridgeport, Conn., are the manufacturers.

A commission of Belgian army officers has recently tested a new automobile tractor which is to be used in the Congo region over the Songololo-Popokabaka route, which was laid out by Commandant Carton with 300 native laborers. The vehicle weighs 3.3 tons empty and will carry a 2-ton load, or 60 packages of the type usually made up for Central Africa, weighing 65 to 75 pounds each. The tires of the rear wheels are 16 inches wide. Control of the vehicle is easy and a speed of one mile in 8.3 minutes is reached. The principal tests were made at Ensival, and the vehicle covered a distance of 13 miles, the steepest grade being 14 per cent. In these trials 5.5 gallons of an alcohol and gasoline mixture in equal proportions were consumed. The consumption was about 0.4 gallon of combustible per mile with a load of 5 tons gross, or 2 tons net, making a cost of $0.013 per ton-mile of gross load, or $0.03 for net load. The distance from Songololo to Kwango is 180 miles, this being the route to be covered, and allowing a speed of 3 miles an hour during 10 hours per day, it would require 6 days to make the single trip. The round trip will therefore require about two weeks, counting the time of loading and unloading, or per year the vehicle can make 24 trips. If this automobile is found to work successfully on the road, there is no doubt that others will be added, and it is estimated that six of these tractors would transport at least 150 tons annually, which would be a great benefit to the traffic of the region.

Correspondence.

The Spider at Work.

To the Editor of the SCIENTIFIC AMERICAN:

Two interesting articles in late issues of your journal prompt me to state that I have made many efforts to ascertain how a spider spins his web from one tree to another.

Spiders are very shy and work mostly at night. Hence my efforts were fruitless for a long time. Finally I captured a spider and confined him in a glass jar. I fed him bountifully, and gave him such attention as to quiet his fears. Often I would take him out into the open air and observe his actions.

If it were cool, damp or windy weather, he would reluctantly leave his quarters. But if it were warm, dry and calm, he readily came forth, and his excited, eager actions gave evidence of the possession of that innate love of liberty peculiar to all animated creatures. On such occasions he was ever upon the alert to escape. I carried him upon my hat or walking cane, held out horizontally.

He would attach a web to the cane and then drop like a flash in order to escape. I always anticipated him and thwarted his plans. He would hang by the web, which he knew would sustain his weight, until I rescued him. I am satisfied that he estimated the distance to the ground, and that he would have succeeded in escaping had I not raised the cane. He would climb up his web and at the same time roll it up. Often I saw him take up a web, roll it into a pellet or ball and store it away, presumably for future use. He seemed to shrink from sunshine, preferring a dense shade, and refused to work while the wind was blowing.

His actions were most interesting when I would cast a living fly into his quarters. Cautiously he would approach it, dexterously capture his prey, and bind him, I believe, with bits of web formerly used and stored away.

In favorable weather he would raise his head and turn to every point of the compass. Whenever I approached a bush he would become excited. I have always believed that spiders depended upon currents of air to transport their cables, but I lacked the proof. Finally my patience and persistence were rewarded. One day, about four o'clock in the afternoon, when the thermometer stood at about 85 degrees in the shade, and the air was so calm that I could not feel any current, although there was a slight movement in the air from northeast to southwest, I selected a place about 12 feet from a wire fence with green bushes in the rear. Here I had the benefit of the sunlight to observe my spider. His actions proved that he appreciated the favorable situation at its true worth. Poised upon the end of my cane, he set his spinneret in motion. I could see the web floating away with every undulation, glistening in the sunlight as it went on directly to the wire. When it caught the spider stopped immediately. His subtile sense of touch told him of his success. Forthwith he began to haul away on his cable until it was taut and fastened to the cane. Then he went over the tight web like one who loves liberty and values time. I thought he had earned his freedom, and likewise that I had gained the information which I so much desired.

W. T. HOLLIS.

Rison, Ark., September 26, 1902.

The Besetting Perils of Venetian Structures.

A correspondent of the London Times has made some astonishing statements in an article on Signor Boni's work in restoring the monuments of Venice. He says that the church of St. Mark, the Doge's Palace, the Procuratie Vecchie, the Zecca, and the churches of Santa Maria Gloriosa, dei Frari, and SS. Giovanni e Paolo need prompt attention if they are not to share the fate of the Campanile. Although too much credence cannot be given to many of the wild rumors of the condition of Italian monuments, it can hardly be denied that the Campanile catastrophe has aroused justifiable distrust of the competency and diligence of Italian engineers. According to the Times correspondent, the Doge's Palace reveals diagonal lesions behind the bookcases of the Biblioteca Marciana; it seems as if the brickwork were tumbling inward. In the Procuratie Vecchie are several serious cracks, caused probably by the wholesale demolition of the internal walls and the stacking of heavy goods in the rooms above the colonnade. The correspondent comments on the folly of the civil engineer corps which is preparing to remove the Biblioteca Marciana to the Zecca. The latter building is already in a sorry condition.

If Venice should really lose these architectural monuments, her doom may be said to be sealed. Commercially, the city is of little importance. Venice has lived simply by reason of her artistic attractiveness; and when that is gone, it is doubtful if European tourists will visit the old city of the Adriatic.

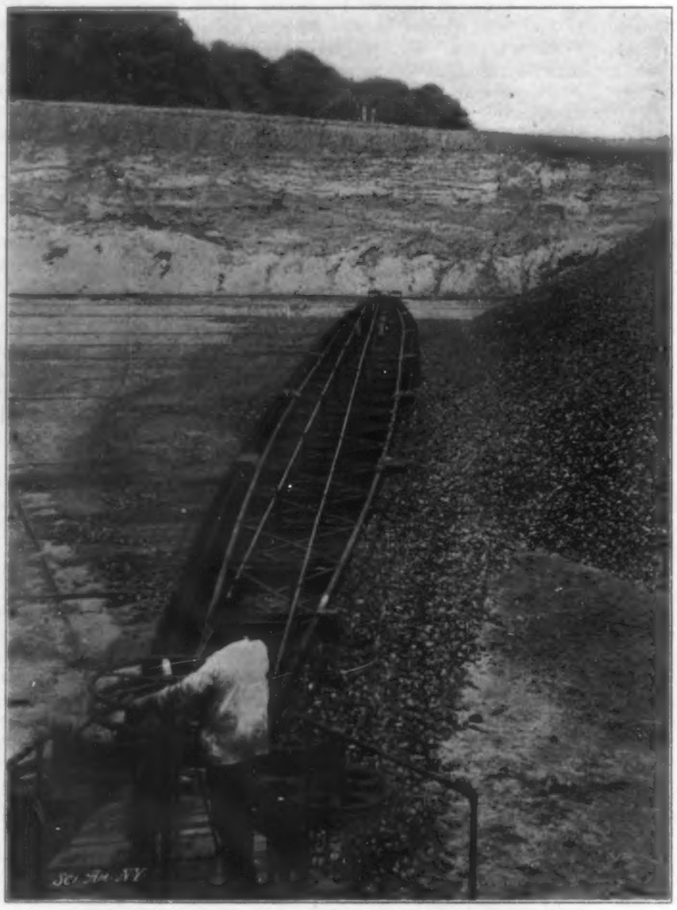
COAL STORAGE.

BY WALDON FAWCETT.

Recent conditions in the fuel market of the United States as brought about by a prolonged strike have directed renewed attention to the subject of the storage of anthracite coal. It has been apparent to a growing extent of late years that with an almost constant demand on the one hand and a varying production on the other, rendered necessary by the conditions at the collieries, a uniform supply can be secured only by the use of a reservoir of large capacity which will absorb the surplus or yield it up as conditions may demand. The methods commonly employed for storing anthracite coal may be divided into two general classes: Those which do not employ machinery and those in which machinery is employed. In the first-mentioned division is the side-hill storage system, the trestle systems with or without reloading tunnels, and the pocket system, while in the second class are embraced the systems which employ machinery in part as well as those in which all of the functions of a storage plant are performed by mechanical devices.

Prior to the introduction of machinery in coal handling operations the effort of all designers of storage plants was to make gravity the sole agent in reloading. In other words, the ideal sought was to store coal in such a manner and at such an elevation that it would flow by natural means into cars. As a result there were evolved the side-hill and trestle systems, various modifications of which are yet in use.

In the side-hill system the coal is stored on a hillside having a slope equal or nearly equal to the angle of flow of coal. A trestle on the hilltop carries a dumping or stocking-out track, whereas the reloading track is located in a trench near the foot of the hill. It was discovered, however, in seeking solutions of the coal storage problem that suitable hillsides were rather scarce, and as a result came the development of the trestle, which is usually built on an almost level area. In its earlier form the trestle system simply consisted of a series of dumping or stocking-out tracks carried on trestles of suitable height. No attempt was made to reload by gravity, all the coal being reloaded by hand. Later there was introduced an adjunct in the form of what is known as a central reloading tunnel. There are two different styles of reloading tunnel, one being located above ground and the other underground. The pocket system of storing coal is limited in its application almost exclusively to the handling of the fuel at shipping piers at tide-water. The coal-storage systems which employ machinery in part usually consist of installations in which the ordinary trestle system, already mentioned, is supplemented by reloading conveyors placed either in the tunnels or against the faces of the retaining walls. Obviously the most interesting coal-storage plants are those in which machinery is used exclusively. Prominent among these are the systems in which tubs and buckets are mounted upon movable bridge tramways or wire rope cableways. Machinery of this type is familiar to a majority of students of industrial progress, owing to its extensive utilization in the handling and storage of iron ore, particularly at the ports on the Great Lakes and at iron-working establishments in the so-called "Pittsburg district."

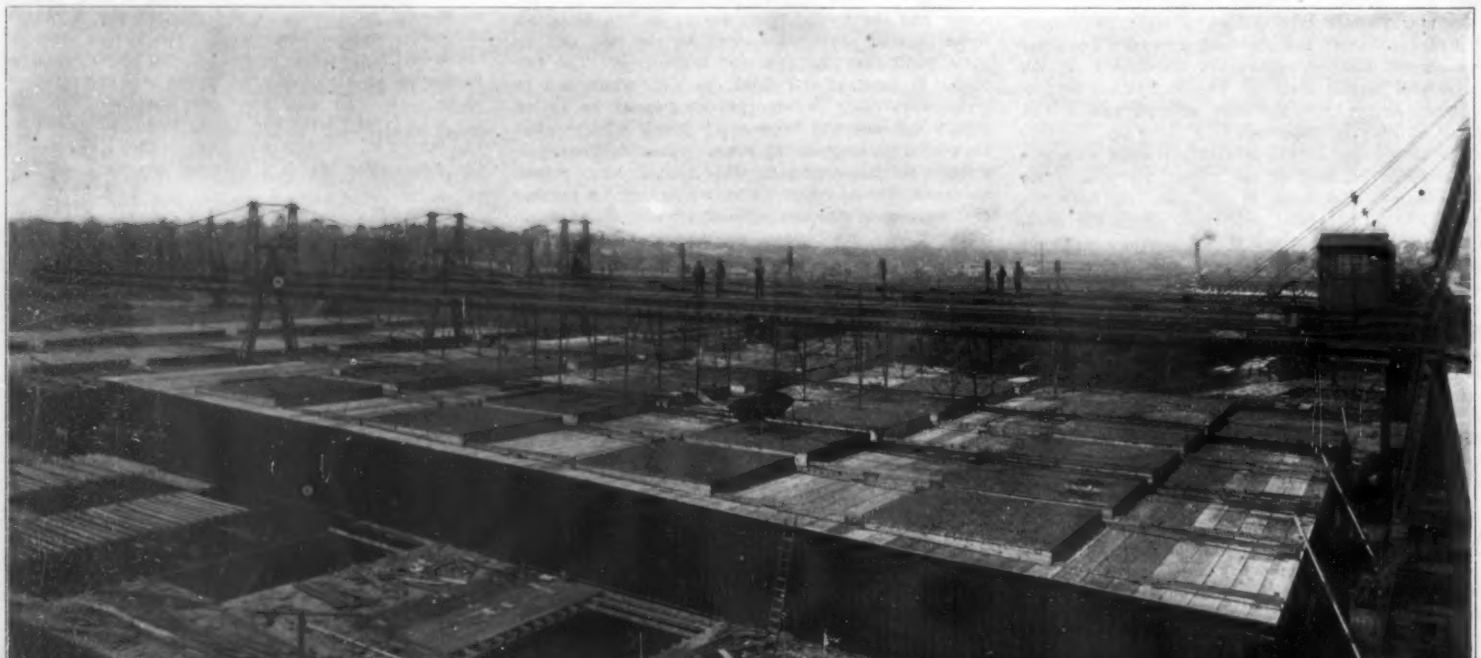


COAL-RELOADER OF THE DODGE TYPE.

Of late the efficiency of plants of this kind—all based on the inventions of the eminent engineer, Alexander Brown—has been greatly increased by various means. There may be mentioned, as contributing causes, the introduction of various types of grab or "clamshell" buckets, each capable of imprisoning from one to ten tons of coal by the closing of their iron jaws and bucket-shovels, which when drawn up the side of a pile of coal will automatically scoop up a load which equals the limit of their capacity. The latest and probably the most interesting innovation in this field, however, is found in the use of such machinery for the storage of coal under cover; the radical departure being found in the fact that the handling machinery is located in the open above the covered storage bins. Bridge tramways of excessive length span the great storage sheds, and the tubs or buckets carrying coal are lowered through hatchways in the almost flat roofs, just as they might be lowered into the hold of a ship loading or unloading at dock.

A marked advance in the coal-storage field is embodied in what is known as the "Dodge system"—a style of plant that is a radical departure from the older methods of storage. In this system the trimming or stocking out is done by conveyors arranged at angles equal to the angle of repose of the coal, and these conveyors receive the coal from cars and build it up into conical piles, beginning the delivery a trifle above the ground line and constantly advancing it to a point a little above the apex of the growing pile. The conveyor trough is constructed to permit this gradual advance of the delivery point, so that after the initial drop into the track hopper there is no further drop exceeding a few inches.

The reloading is accomplished by means of an open-side conveyor which works against the edge of the



A CONVEYOR USED FOR STORING COAL UNDER COVER.

pile and follows up this edge as the coal is removed. The conveyor is mounted on a pivoted frame moved by power and so arranged as to be wholly under the control of one man. The reloading conveyor carries the coal without transfer to the reloading tower, where it can be delivered either directly into cars or else screened and then delivered into cars. A unit of this system consists of two trimming conveyors and one reloading conveyor arranged midway between them. For large capacities the dumping tracks are arranged on one side of the plant and the reloading tracks on the other. By this arrangement it is possible to carry on simultaneously the operations of trimming and reloading without any interference of cars or choking of tracks.

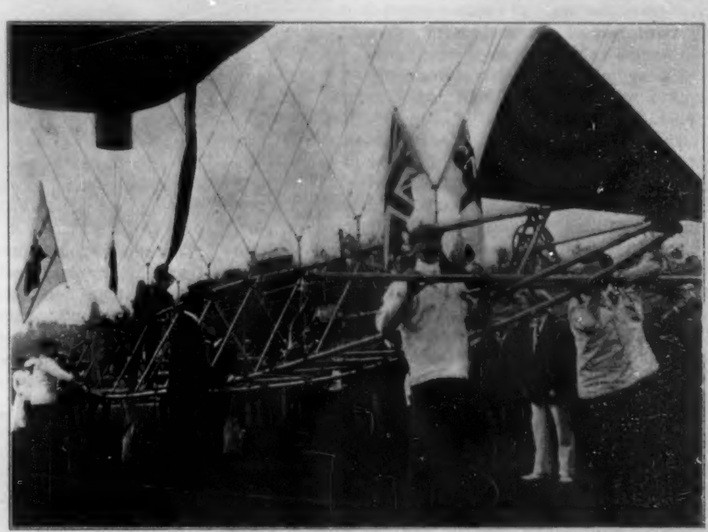
In the coal-storage plants of this new system each machine is of sufficient capacity to handle 1,800 tons in ten hours. In the operation of the plant of this character the coal received from cars in a hopper located beneath the receiving track is fed through a chute to the conveyor of the trimming machine, which delivers it upon the ground or at the apex of the pile as it forms. The bottom of this trimming conveyor is a steel ribbon, usually twelve inches wide, which is wound upon a drum located at the foot of the truss and arranged to be drawn out in grooves fixed in the conveyor trough, so that its end, which is the only discharge point for the coal from the trimming machine, shall always be at the constantly rising and receding apex of the pile. The reloading machine is composed of a horizontal and an inclined portion, both working together so as to render the carrying of the coal continuous from any point on the horizontal portion to the upper end of the inclined portion, where a small pocket is provided into which the coal flows and from which it is discharged over screens into cars or vessels.

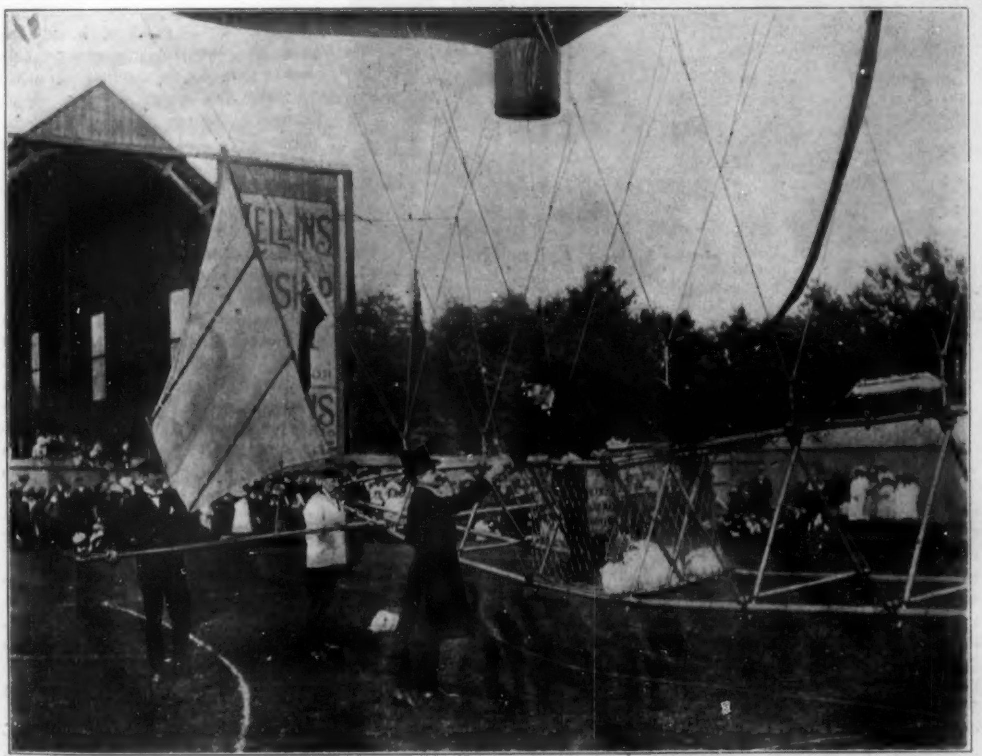
This system of coal-storage is employed in the 180,000-ton plant of the Philadelphia & Reading Railway Company at Port Richmond, Philadelphia. However, the Scranton plant erected for the Delaware, Lackawanna & Western Railroad Company has the largest trimmers and the longest reloader yet constructed under this system. Each of the two floors holds 50,000 tons in a pile 78 feet high and 310 feet in diameter, whereas the horizontal portion of the reloader is 300 feet in length. This plan of storing fuel is also adapted to use under cover in regions where heavy snowfall makes necessary the housing of all stored coal. For instance, the Lehigh Valley Coal Company has at West Superior, Wis., a plant which provides storage for 100,000 tons of anthracite coal in two circular steel buildings each 246 feet in diameter and 90 feet in height.

THE SPENCER AIRSHIP AND ITS THIRTY-MILE TRIP.

BY WILLIAM EDWARD WARD.


Building Spencer's Airship.


The Car Seen from the Front. Photographed Before the Start.


Spencer Starting on His Trip. The Acronaut is Shaking Hands with Lachambre, Builder of the Santos-Dumont Ships.


The Ascent from the Grounds at Crystal Palace, London.

THE THIRTY MILE AIRSHIP FLIGHT OF STANLEY SPENCER.

On September 19 London was surprised to see an airship hovering over its chimneys and spires. The air was apparently quite calm, and the ship steadily headed to the northwest, traveling about eight miles an hour. Months ago Londoners heard in a vague way, that an English-built airship was in existence, but the matter excited little interest at the time, and latterly was quite forgotten.

The new airship is the work of Spencer Brothers, a firm of aeronauts now in the third generation, built in their own factory. It was sailed by Stanley Spencer, the second of the three brothers. For three months the air-ship has been awaiting trial in its shed in a South London suburb; and on several occasions it has made experimental captive flights. On September 19 the unusual stillness of the air tempted the aeronaut on what proved a successful maiden trip. At the commencement of his journey he circled in a couple of "figure eights" and repeated the maneuver when over the west of London. For the rest he covered about twenty miles in a trifle over two hours, alighting without mishap just before dark.

The balloon follows the torpedo-shaped construction made familiar by Santos-Dumont, but has more blunted ends. Consequently it has not the graceful lines of its French predecessor. The frame, which bears the aeronaut and the machinery, is constructed of bamboo held taut by piano wire. As seen in the air, it bears some resemblance, in its proportions, to a skeleton canoe. Three long strips of bamboo run the length of the frame, and are kept in position by struts bound triangularly, the base of the triangle being horizontal. The frame is slung from the bag by fine ropes. The principal feature of the construction is the position of the propeller, which is placed at the bow of the ship instead of, as is usual, at the stern. The inventor considers that the effect of this innovation will be to enable the ship to hold a more even course.

The motive power is supplied by a small petroleum motor swung in the forward end of the frame and firmly bound in position by piano wire. A small cylinder to feed the engine's water jacket is fastened just over the engine. Directly below the engine is the condenser. The fuel tank is fixed to the upper bamboo, but further aft to shield it from the motor flames. A thin rod of steel—the engine's shaft—runs forward to a gear wheel, the axis of which is the propeller shaft.

Toward the stern of the balloon is the aeronaut's stand, inclosed in netting. Behind him is the rudder, a large quadrilateral sail suspended by ropes between the ends of the balloon and the frame. The construction places all the mechanism—except the rudder—directly in front of the navigator, an obvious advantage in cases of sudden emergency.

All the working parts are under absolute control from the car. Two cords guide the rudder. The pro-

peller is started or stopped by a friction clutch, operated by a lever; another lever controls the speed of the engine; and an electric switch regulates the ignition devices.

The envelope is of English silk, heavily varnished, and when inflated is 75 feet long. Its capacity is 20,000 cubic feet. The safety valve is placed directly over the car and may be opened by a cord. It is, however, constructed to work automatically; it worked successfully on the trial trip. Sand ballast is carried on the aeronaut's stand; and to decrease the buoyancy of the balloon, air may be forced into it by a small hand blower placed just in front of the stand.

The weight, with netting and gear for supporting the keel, or *nacelle*, is 290 pounds. The keel, or *nacelle*, which in outline approaches that of a well-formed tipcat, is made entirely in skeleton of bamboo, trussed triangularly, and rigidly stayed throughout with steel wire stays. When suspended it is carried 10 feet below the bag. The motor, which is carried on the forward half of the keel, being placed 20 feet from the escape valve.

The engine—a 6.8 horse power Simms petrol motor, with Simms-Bosch ignition—serves to drive the propeller.

The propeller itself is the design of Sir Hiram Maxim, who is an enthusiastic follower of aeronautics. It is double-bladed, built of thin strips of carefully selected pine, weighs 28 pounds, is nearly nine feet long over all, and a full four feet at its broadest part.

The drive is communicated to the screw from the engine shaft by means of doubly universally-jointed propeller shaft, steadied in its center by an adjustable ball bearing slung by four wires from the angles of the keel frame. The engine shaft carries a steel pinion, which meshes with a gun-metal spur wheel ten times the diameter of the pinion, this spur wheel being carried on a shaft attached to the rearward universal joint of the propeller shaft. Thus the propeller revolves at one-tenth of the speed of the engine shaft, the normal rate of which is 1,500 revolutions per minute. The usual coned friction clutch forms part of the engine flywheel, and a free-wheel clutch with starting band is also fitted to the engine shaft. Cords from the clutch and starting clutch mechanism are led back to the aeronaut's car, which consists of a platform on bamboo supports situated in the center of the rear half of the keel. The engine can therefore be started and disconnected from the propeller shaft, and by similar means the sparking is advanced or retarded by the aeronaut at will. At the stern of the keel is placed the rudder, with lines to the car, from which also depends the balancing trail rope. Just forward of the car, on the top of the keel frame, is placed a blower, connected by silken pipe with the interior of the gas bag, and which can be operated by the aeronaut when it is necessary to control the distension and equilibrium of the balloon.

To avoid the danger of explosion when the valve is opened and hydrogen emitted, the motor's exhaust pipe is incased in wire gauze, somewhat after the fashion of a miner's safety lamp.

With a capacity of 20,000 feet, the Spencer airship is about three-quarters the size of the Santos-Dumont No. 6. When fully inflated with hydrogen (at a cost of $250) it has a gross lifting power of 1,000 pounds. The envelope weighs 360 pounds, and the car with all the machinery weighs 300 pounds. This leaves a margin of 340 pounds to be divided between the aeronaut and the net lifting power.

I saw Mr. Spencer almost immediately after his trip, and found him enthusiastic that the construction of his ship was on right lines. He has commenced building a much larger one, of which the only particulars as yet obtainable are that it will carry four or five persons, and will embody all the principles of his No. 1.

London, England.

A Communication from Leo Stevens.

The Editor of this journal has received from Leo Stevens a brief account of his recent ascent at Manhattan Beach, which was commented upon in the Scientific American. Mr. Stevens assures us that the Santos-Dumont balloon steered by Mr. Boyce traveled directly northeast and landed about a mile and a half from the starting point. Mr. Stevens states that he was traveling above this ship on the same line, that when reaching Sheepshead Bay he turned two complete circles and that he then ventured on the trail of the Santos-Dumont. After Mr. Boyce had pulled his emergency cord Mr. Stevens states that he started on his way back against the wind, and that when directly over the Brighton Beach race track, he turned again, sailing directly to Coney Island. On his way back to Manhattan Beach he lost his sparking plug and had to descend in a network of wire. Mr. Stevens claims that the actual distance which he covered was about seven miles.

Mining Water for Coal.

The straits to which New York city has been put by reason of the coal strike have given birth to a most curious occupation. When coal began selling at $10 a ton a Bridgeport wrecking company decided that it was about time to begin the work of mining Long Island Sound. According to the New York Tribune, the method of water mining is quite simple.

The wreck of a coal barge is first located by means of the Lake submarine boat, described some time ago in the columns of the Scientific American. Two boats—"wreck-finders" as they are called—are run out to the territory where the coal wrecks are supposed to be. In each boat about a mile of inch rope is contained. As the boats run alongside each other the ends of the ropes of each boat are spliced, making a continuous rope two miles long, and thereby lashing the two boats together. The wreck-finders then travel in opposite directions for about half a mile and thereupon run parallel to each other. The rope is paid out through a ring in the end of an iron pole projecting over the stern. After sufficient rope has been reeled off, two 300-pound weights are run down the rope from the sterns of each boat. Rapidly sinking to the bottom, these weights hold the rope a short distance from the ground, so that it forms a sweep half a mile long and is bound to catch anything that may come in its way. When the sweep rope catches the boats are stopped, the drums reversed and the rope wound up. The boats travel toward each other until they are almost over the point where the sweep rope is caught. A sounding is taken, and the lead carefully examined for traces of coal. Sometimes the lead tells nothing. A harpoon is then sent down the rope. If it sticks there is probably wood to be found far down in the water. If the harpoon is pulled up with its end blunted, iron or rock may be expected. A diver is now sent down to explore the find. He estimates the quantity and quality of the coal discovered, and decides whether it should be taken out by buckets or by suction pump. Sometimes the diver fastens a floating buoy to the wreck, and the sweep boats proceed on their way, looking for more coal cargoes that have sunk.

Now comes the turn of the lighters. By means of derricks or suction pumps the coal is raised to the surface. Not infrequently a coal wreck is found where the lighter can be pumped full of coal in half a day. Indeed, a wreck that will not fill the hold of the lighter in a day is not considered much of a find. A hundred tons of coal recovered in this way is deemed a fair day's work. When it is considered that a number of coal barges are sunk during every heavy storm on Long Island Sound, it will be readily seen that the business is profitable even in times when there is no coal famine.

The island of Guam was recently visited by many earthquakes. Some of the shocks were violent; indeed, so violent that the government buildings have been badly damaged. A tidal wave destroyed a large part of the crops and caused much suffering among the islanders. Commander Seaton Schroeder has telegraphed that the total damage amounted to $45,000 to government property.

Taking the Hurdles Between the Lions and Tigers.
THE SCIENTIFIC TRAINING OF WILD ANIMALS.

THE SCIENTIFIC TRAINING OF WILD ANIMALS.

BY HAROLD J. SHEPSTONE.

There is no disputing the fact that the training of wild beasts has developed into a science, and no man has given the subject such serious consideration as Mr. Carl Hagenbeck, the world-famous animal dealer, of Hamburg. When in that city recently I called at his interesting animal emporium, for it is nothing else, and sought to discover the methods adopted at this unique training establishment.

At the time of my visit a group of twelve seals were undergoing stage tuition in a large cage, in the open ground, while in another a tiger was being taught to ride an elephant. The seals were being taught their tricks by an Englishman, and I was assured that they had made excellent progress during the seven months they had been under instruction. One of the larger ones, which the trainer affectionately patted on the head every now and again, could already take a small ball in his mouth, bounce it on the floor, catch it on his nose, and waddle with it, balanced in the air, onto his perch. In the other cage, which was under cover, the tiger displayed no small amount of intelligence, and seemed to perfectly understand what was wanted of him. If anything, the elephant was the more nervous of the two.

During the last thirty years Mr. Hagenbeck told me he had trained over seven hundred large animals; such as lions, tigers, bears and elephants, while most of the lion-tamers of Europe and America have passed through his hands. His methods are unique; he believes in individual training, and to him a new lion is a beast endowed with distinct characteristics, and therefore demands separate study and attention. "Like everything else," said Mr. Hagenbeck, "the business of animal training has considerably advanced during the last quarter of a century; and whereas it was considered wonderful for an animal, say a lion, to perform certain tricks, it is now almost essential for the would-be trainer to go through a series of evolutions with quite a number of different animals. It is not difficult to see that to train one animal is an entirely different matter from training a group of say twenty different beasts. I was the first to conceive the idea of training various animals to perform together.

"The first group of various wild animals which I succeeded in training to perform in the arena together, after many weary months, was exhibited at the Crystal Palace, London, in 1891. Their performances caused a sensation at the time, and thousands came daily to see them. After a few months the animals became very sick, so I took them back to Hamburg. Within six weeks after my return they all died. I found it extremely difficult to get good meat on which to feed them while in London. Such animals as lions and tigers like meat soon after the bullock or sheep is slaughtered. It was a great loss to me, for they had not been exhibited long before two American gentlemen offered me $50,000 for the group. I soon got another group ready, however, which I took over to Chicago, to the World's Fair, and they proved a great success.

"I have been busy lately making very extensive arrangements for exhibiting my trained animals in America. I have already sent one group over consisting of sixteen various animals, while by the middle of September another consignment will leave Hamburg for New York, containing a sufficient number of trained beasts to make up three distinct groups. These will travel all over the United States, performing at all the principal cities, and I am sure they will excite no little interest." They will be managed by a concern known as the Hagenbeck Trained Animal Company, an organization composed of four gentlemen, including Mr. Hagenbeck.

The most interesting of these groups, probably, is that made up of two large Nubian lions, one large cross-breed of a lion and a tiger—an entirely new and decidedly interesting beast, of which more anon—three Bengal tigers, two large Indian leopards, two South American pumas, two large polar bears, and four boarhounds. Incredible as it may sound, Mr. Hagenbeck assured me that it took four years to train this one set of animals. Although the group is made up of only sixteen beasts, over sixty were purchased and partially trained before the desired number was obtained. The others were useless from a performing point of view. This is where Mr. Hagenbeck scores over his competitors. Being a dealer in wild animals, as well as a trainer, those beasts that are unfit for the stage are sold to zoological gardens and menageries.

A wild adult animal is of no use whatever to the trainer, but a young forest-bred beast can be trained as well as those born in captivity. So well are the animals in the group mentioned above trained that they will come out into the arena, one at a time, at the crack of the whip, and take up their positions on the stools or pyramids. According to Mr. Hagenbeck, anyone may become a wild beast trainer, provided he is prepared to give the necessary time, and is endowed with patience, tact, and good judgment. He must have a love for animals and never treat them harshly. The great worry in getting mixed groups together is to get the beasts to agree. If an animal is not liked by its fellows, another one must be secured. Keeping it would only mean continual fighting, and it is often necessary during the early stages of the training to keep men in the cages all night to prevent the beasts from quarreling.

It is interesting here to note that $50,000 has frequently been refused for these groups of trained beasts. Mr. Hagenbeck told me that they often cost him that to get together and train. A tiger, for instance, valued at say $500 would be worth ten times that amount after a couple of years of training. Curiously enough, Mr. Hagenbeck does not look to receive a large profit from the training side of his business, but rather regards it as a good advertising medium. His principal income is derived from the selling of all kinds of rare and wild animals to public zoos, menageries and private parks. For this purpose he keeps a large stock of animals on hand.

At the time of my visit he had the following animals in his depot: Sixteen lions, eight Bengal tigers, seventeen pumas, black panthers and jaguars, twenty-one bears, hyenas and wolves, eleven elephants, eighteen wild pigs of different sorts, twenty-seven camels, six dromedaries, eight various llamas, six zebras, three wild asses, four Mongolian wild horses, eight American bison-buffalo, eighteen yaks and various antelopes, thirty-three deer of different varieties, nine various wild sheep and goats, twelve ostriches, sixty-one cranes and storks, one hundred and seventy-two swan, geese and ducks, lots of monkeys, reptiles, pheasants, vultures, eagles and different varieties of small animals.

This of course, gives the trainers at Hamburg a varied and large stock to pick from, and explains the reason why no menagerie the world over can hope to turn out such interesting tableaux. All the principal groups of trained wild animals which have been exhibited in Europe, America, India and Australia were first trained in Hamburg. In addition to the three groups in America, there is another performing at Blackpool, England, and another at Nice, on the Riviera. The former is made up of twenty-one animals, between three and four years of age, and the other of sixteen animals.

Mr. Hagenbeck has won considerable fame as an animal importer, and now claims the distinction of being the largest dealer in wild animals and curious beasts in the world. He has made some decided hits at different times in securing specimens of the rarer animals. Thirty years ago he obtained an African rhinoceros for the London Zoological Society, which was the first rhinoceros seen in Europe since the days of the Roman Amphitheater. Seven years ago he imported a Siberian tiger, and four years ago a Persian tiger. Four years ago, too, he landed in Hamburg two lions from Balkash Lake, in Central Siberia, and a couple of tigers from Russia Turkestan. These beasts created quite a sensation in zoological circles, as they were the first species of their kind ever seen in Europe. Last October his depot was enriched by a stud of twenty-eight wild horses from Mongolia. They were caught, as foals, in a district some twelve days' march beyond Pekin, and after much trouble shipped to Hamburg, at a cost, all told, of over $25,000. They were quickly snatched up by the leading zoos, many of them being sold at $2,500 apiece.

A Group Trained After Eighteen Months of Teaching.

Mr. Hagenbeck has conducted some interesting experiments recently in the cross-breeding of animals. Mention was made above of a cross-breed of a lion and a tiger. The peculiarity of this beast is that it has a tiger's body and a lion's head. It weighs nearly five hundredweight, and measures ten feet from the tip of his tail to the tip of his nose, and stands about four feet high up to the top of his shoulder. There are five other similar animals at Hamburg. Mr. Hagenbeck has also crossed zebras with horses, at the advice of Prof. Hewitt, of Edinburgh, Scotland. He recently helped the Duke of Bedford to cross Persian fallow deer with ordinary European deer, so that a bigger and stronger deer could be obtained. The whole idea of this crossing, of course, is to secure a better blood and a stronger breed. In this way he has secured a better breed of pheasants, by crossing pheasants from Central Asia with the European variety. They are larger and heavier birds, stronger on the wing and prettily marked. In conclusion I would add that the great dealer is now busy building a zoo at Stellingen, a suburb of Hamburg, which, when completed, will be the most singular garden of its kind. It will be unique in the manner in which it is laid out. It is to be opened next May.

London, England.

A Trained Walrus.

Dr. Woodbury's Collection of Metropolitan Bacteria.

It will be remembered that a few weeks ago the Scientific American called attention to the fact that Dr. Woodbury, Commissioner of Street Cleaning of New York city, had determined to carry out a series of experiments for the purpose of ascertaining the bacteriological condition of the air of New York city. The first results of the experiments have been given to the public. To one who is not a bacteriologist, the conditions which have been found to prevail are startling.

At various points, selected to give strong contrasts, gelatine-coated plates were exposed for one-half hour at curb level and six feet above the curb. The micro-organisms thus collected were transferred to the usual culture medium and allowed to propagate. Exactly what the germ colonies contain has not been definitely ascertained; that they carry enormous numbers of disease germs goes without saying. But it has at least been established that the air near the curb level is much more heavily laden with what is grimly called "rich bacterial flora" than that six feet or more above the sidewalk. It is therefore evident that unclean streets are most unsafe playgrounds for children.

For those who consider municipal cleanliness rather more costly than the end attained would seem to warrant, we recommend the useful object lesson that a plate exposed for one-half hour in clean, residential streets with well-swept asphalt pavements shows five isolated pinhead colonies after an enlargement of 700 diameters; while one exposed for the same length of time under precisely the same conditions of hour and weather, in an East Side street flanked with crowded tenements—from the windows of which tons of refuse are daily thrown—shows nearly 10,000 colonies, some as large as a thumbnail.

A more striking argument in favor of clean streets could hardly be found.

On the See-Saw.

Dinner Time at the Training Quarters.

THE SCIENTIFIC TRAINING OF WILD ANIMALS.

RECENTLY PATENTED INVENTIONS.

Agricultural Implements.

MOWING-MACHINE.—B. C. White and T. J. Jones, Catlin, Ill. In mowing machines there is always a tendency of the knives to become clogged, whereby the machine is with difficulty started from a position of rest and whereby the knives do not at first act with proper efficiency. The purpose of this invention is to overcome these difficulties, the motive power being first applied to starting the sickle, thereby unclogging the cutting mechanism, so that when power is applied in the usual way, the machine will move forward easily.

Electrical Devices.

ELECTRICAL TYPEWRITER. — Charles Gibbs, New York, N. Y. Mr. Gibbs is the inventor of a typewriter operated by electricity. The machine is neat, compact and simple in construction, having nearly all its parts relating to electricity so disposed as to be readily accessible. A revolving cylinder is provided on which a series of buttons are located which correspond to the characters. In operation the desired buttons are depressed and as the revolving cylinder brings the same into contact with a series of brushes the proper characters are printed on the sheet.

ELECTRICAL SYSTEM OF RECORDING AND CHECKING AS APPLIED TO RAILWAY SIGNALING.—W. H. M. Weaver, Macon, Ga. This electrical recording and checking apparatus operates as a check upon the operator in the manipulation of his railroad signal apparatus and also upon the dispatcher. The act of reversing a semaphore-arm sets in operation an electrical device by means of which a telegraphic sign is transmitted to the central office and duly registered by means of the dispatcher's telegraphic instrument and also by means of a time recorder.

SELECTIVE CALL FOR TELEGRAPH OR TELEPHONE LINE.—W. Palmer, Jr., Rincon, New Mexico. The object of this invention is to enable an operator or train dispatcher on a telegraph line to cause an alarm bell to ring at any one or more of the distant stations without ringing the bells at the other stations, and to enable a subscriber or the central office of a telephone line to accomplish the same results under similar conditions.

Engineering Improvements.

ROTARY ENGINE.—W. F. Evans, Chicago, Ill. Mr. Evans is the inventor of an improved rotary engine of simple and durable construction which is very effective in operation, easily reversible, and arranged to utilize the motive agent to the fullest advantage.

Machines and Mechanical Devices.

VENEER-BENDING MACHINE.—E. Aber, Jacksonville, Texas. This machine is designed to bend portions of veneer with a comparatively slow movement, subsequent to sizing or moistening the work and while it is in engagement with a heated form, thus giving the veneer an opportunity to become thoroughly heated while being bent and making it practicable to bend the stock sharply and thick enough to make baskets for heavy use.

INDICATOR FOR SAWMILL-KNEES.—J. D. Beatty, Klondike, N. C. The invention relates to indicators used for sawmill knees for showing the position of the log to be sawed, so that the thickness of lumber to be cut away may be readily ascertained and that the width of the log may be exhibited in units of boards of different thickness.

SPIRAL CONVEYER.—C. G. Williams, Dalton, Iowa. The invention relates to spiral conveyors for moving grain or other material, and it provides certain improvements whereby several sections of the spiral shaft can be readily and securely fastened together and any one section requiring repairs may be readily removed at any time without disturbing the other sections.

KRAUT-CUTTER.—G. H. Kinkade and L. Mager, Hardin, Ill. An improvement in kraut-cutters is hereby provided whereby cabbage may rapidly and easily be cut into thin strings or kraut. A simple and effective device is afforded by the invention, which is composed of few parts not likely to get out of order and adapted to be readily repaired.

BALANCING DEVICE FOR TURBINE GATES.—W. W. Tyler, York, Pa. Mr. Tyler hereby provides certain new and useful improvements in balancing devices for turbine-gates whereby the gate is completely balanced at any stage of its opening so that the pressure of the water neither tends to open or close the gate and hence the latter can be easily opened or closed by an attendant.

FRAME FOR METAL-SHEARING MACHINES.—B. Wesselmann, 2 Gartenstrasse, Gross Lichterfelde, near Berlin, Germany. The frame consists of two parts, one of which carries the cutter or blade, which during the process of cutting remains stationary, while the other part constitutes what is generally known as the "body" or "trunk" of the frame. By this method of splitting up the shear frame, material advantages are gained both in regard to the use of the shears and in regard to their manufacture.

FILTER.—Theodore Linke, New York, N. Y. This filter belongs to the type having a filter-stone mounted to rotate and a cleaner-stone therefor. Mr. Linke provides a simple means for causing the cleaner-stone to follow the reduced diameter of the filter-stone when it wears away and to maintain equal pressure at all times.

INDICATOR.—T. F. McCullough, Memphis, Tenn. Mr. McCullough is the inventor of an indicating apparatus for displaying successive numbers or other characters. It is specially adapted for use in barber shops and like places where persons wait for service in their turn, and when so placed it may with advantage be used in connection with a check box, the customers receiving numbered checks from the check box and the number of these checks being subsequently indicated in their successive order by this indicator.

Railway Contrivances.

CAR-MOVER.—H. C. Harrington and W. M. Towers, Rome, Ga. Briefly stated the invention involves a peculiar frame to which a lever is pivoted, a novel means for clamping the rail and novel details of construction whereby a leverage may be brought to bear upon a car wheel to move the car.

TRACK-BRAKE.—T. S. Butler, Vandergrift, Pa. This brake belongs to that class of car brakes in which the braking device is applied to the rails, thus saving wear on the car-wheels. With this improved construction the brakes may be applied with great force whenever an emergency occurs. The wearing parts may be renewed at slight expense.

Vehicles and Their Accessories.

BICYCLE-FRAME.—R. F. Monahan, Buffalo, N. Y. Mr. Monahan provides in this invention novel features of construction for the frame of a bicycle which will render its rear portion measurably resilient and afford necessary strength to the frame. The employment of this improvement will increase the benefits derived from the provision of pneumatic tires, and add to the durability of the bicycle as well as to the ease of the rider in traveling over rough places.

DRIVING MECHANISM FOR BICYCLES.—K. Brooks, New York, N. Y. The purpose of the invention is to loosely mount the front sprocket on the crank-shaft of a bicycle and drive the sprocket from the crank through a cushioned yet positive connection. This connection is such as will tend to obviate severe shocks to the machine, thus adding to its lifetime and contributing to the comfort of the rider.

BRAKE MECHANISM.—H. W. Cooley, Lost Valley, Oregon. An improvement in operating-levers and holding devices for wagon-brakes has been devised by Mr. Cooley. The operating mechanism may be manipulated by a person in the vehicle, to firmly set and hold the brake, or it may be operated to set or release the brake by a person riding on a wheel-horse.

BICYCLE SPROCKET AND CRANK.—G. Spence, Newport, R. I. The invention relates to an improved sprocket and crank secured thereto, more particularly for use on bicycles. The device is a neat and compact structure which may be cheaply made and is not liable to get out of order. The ball-bearings are centrally disposed and the sprocket is at one side so that it may be connected in the usual manner to the rear sprocket. By this arrangement, although the alignment is upon the side, yet the wear is in the center of the machine.

MOTOR.—C. J. Cullen, Jersey City, N. J. This motor is more strictly adapted for use in connection with automobiles. The construction is simple and the motor, which is mounted to rotate with the driving axle, comprises a plurality of cylinders, the pistons in diametrically opposite cylinders being so connected with a stationary crank-shaft that there will be practically no dead centers upon the rotation of the motor. A simple form of compensating gear is provided for difference in travel of two traction wheels while turning corners.

Miscellaneous Inventions.

CHECK-PERFORATOR.—Maxwell Keane, New York, N. Y. This check perforator provides a means whereby figures may be readily punched into the body of the check so as to protect it against changing the amount of the check. The device comprises a base-plate having a series of perforating teeth and a lid hinged to the plate which will fold flush upon the base-plate and thus cause perforation of the check.

VAULT-LIGHT.—A. De Man, New York, N. Y. This vault light is more especially designed for illuminating subways, basements, vaults, and the like, and is arranged to avoid the frequent breaking or chipping of the glass lenses as heretofore employed and to ensure full utilization and distribution of the rays of light to properly illuminate the underground chamber.

ICE-RUN.—H. D. Simpson Coxsackie, N. Y. This invention provides an improved ice-run for stowing blocks of ice alternately into adjacent rooms in an ice-house without danger of injuring the blocks. By the use of this invention the rooms may be evenly and properly filled without requiring interruption or stoppage of the elevator carrying the cakes of ice by the main run from the water below.

RADIATOR.—A. Eichhorn, Orange, N. J. This radiator is divided into two divisions so arranged that either may be heated independently at will. It is preferred to have one section of the radiator much larger than the other and in operation to keep the smaller heated continuously and then, if maximum heat is desired, to adjust the parts so that the larger section also may be heated.

FOUNTAIN-COMB.—J. R. Harrison, Barnwell, S. C. This invention provides an antiseptic fountain-comb especially adapted for the hygienic treatment of the scalp and hair, and for washing the scalp and removing the dandruff while combing the hair. The construction is such that when the teeth are brought in contact with the scalp any hygienic fluid carried by the body of the comb will be automatically discharged at the tip of the comb-teeth and brought into direct contact with the scalp.

PRODUCTION OF PLASTIC ARTICLES.—E. Lottier, West Hoboken, N. J. Mr. Lottier hereby provides certain new and useful improvements in the production of plastic articles, such as boot and shoe heels and various other articles heretofore mainly formed of leather and like material. A heel thus formed will be found very durable and may be readily nailed or otherwise fastened in position on the boot or shoe.

COMPUTING-CHART.—L. B. Manley Duluth, Minn. This chart is particularly adapted for use in insurance offices, banks, and the like, and provides a simple means whereby the number of days between any two given dates may be quickly ascertained, at the same time indicating the per cent of the annual premium earned by a policy for the said number of days. In addition to this, indices are provided in connection with the device, referring to numbered lines in cancellation tables.

PEN OR PENCIL-HOLDER.—J. S. McClung, Pueblo, Colo. In public schools it is considered of advantage for the preservation of the health of the scholars to provide each one with a pen and pencil for individual use and to require the rule against indiscriminate use of such instruments to be strictly observed. The object of this invention is to provide a holder for holding a number of pens or pencils separated and clearly distinguished from each other by suitable designating characters, so that each pupil will be enabled to quickly select his individual pen or pencil at the opening exercises and return the same correctly within the holder at the end of the day.

WRENCH.—T. H. Cahill, Terra Alta, W. Va. In this wrench the movable jaw may be quickly locked in any desired position and can be easily released for adjustment to another position, as is frequently desired in the use of monkey wrenches. The parts are simple in construction, easily operated and not likely to get broken or out of repair.

TORPEDO-SHELL PROTECTOR.—J. M. Hatfield, Corning, Ohio. The invention is an improvement in devices for use in connection with oil-well torpedoes, being designed to provide a protector applied to the torpedo shaft and to operate as a guide for the same in passing the shell through the casing of the well, whereby to avoid the friction and jars incident to such operation.

BURNER.—J. L. Jones, Jr., Dallas, Tex. An improvel burner is hereby provided for use in fireboxes of boilers and other apparatus more especially designed to burn crude oil. The burner is arranged to develop a constant flame for producing a high heat in the firebox, at the same time insuring complete combustion without the production of smoke and obnoxious unburned gases.

SHEET-METAL PIPE.—F. L. Filson, Point Pleasant, W. Va. Mr. Filson provides a simple means for securing the edges of stovepipes together, so that accidental separation of one joint from another will be practically impossible. The pipe is what is termed as "nested" pipe, because, for convenience in transportation, the edges of the sections or joints are to be left open, so that several joints may be placed one within another.

BOOM RIGGING.—F. V. Nielsen, San Francisco, Cal. Ordinarily booms swing at their inner ends against the mast and iron or other metal sheets are secured on the masts to take the wear. Water getting beneath these plates rots the masts and in endeavoring to avoid this injury Mr. Nielsen provides an improved construction which will efficiently support the boom and permit the movements thereof in various directions required.

KNOCKED-DOWN BANANA-SHIPPING CRATE.—J. Conrad, Chicago, Ill. The invention provides for the compact disposition of the parts comprising the crate in shipping the same back to the owner, thus effecting economy in transportation charges and enabling a large number of crates to be stored in a car or other place. The crate is designed to be quickly and easily expanded for service, and will not collapse when loaded.

STRIP FOR SECURING GLASS PANES.—J. Swannell, Red Bank, N. J. Mr. Swannell is the inventor of an improved means for securing glass panes and analogous objects in position, more particularly in windows and similar structures. The construction of the strip is such that it may be conveniently used for any thickness of glass.

MIRROR-HANGING.—J. G. Allen, Ubly, Mich. The invention relates to improvements in devices for hanging and supporting mirrors and it aims to provide a simple means for holding in a main frame a mirror at any desired angle. Another object is to provide in connection with the main frame devices for holding various articles.

DESIGN FOR SHADE-CLOTH. — J. H. Wright, New York, N. Y. The design consists of serpentine open-work scroll-figures extending over a mosaic background and irregular lines of circular figures between the said serpentine figures.

PENCIL AND SHARPENER THEREFOR.—R. Y. Cormack, Jamaica, N. Y. Certain new and useful improvements are provided in this invention for pencils and pencil-sharpeners, whereby the sharpener forms a fixture of the pencil to permit the user to quickly and conveniently sharpen the pencil and allow convenient adjustment of the sharpener on the pencil as the latter wears away.

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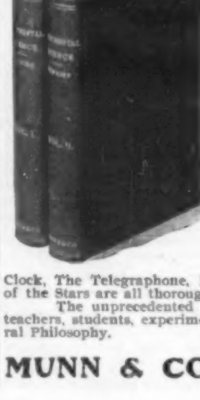

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(8720) J. L. B. asks: 1. What battery shall I use, and how many cells of the same, to light two 8 candle power lamps of 8 volts and 2 amperes? A. Five cells of the plunging bichromate battery will light two 8-volt 2-ampere lamps. The battery is described in Scientific American Supplement No. 792. 2. Why is the magnet in a telephone receiver permanent? A. The magnet in a telephone is permanent in order to furnish the field of force which causes the current in the transmitter to vary with the vibrations of the diaphragm. An electro-magnet would be more expensive and difficult to maintain. 3. What is the difference in construction of a direct current and an alternating current motor? A. A direct-current motor has a commutator, an alternating-current motor has rings to receive the current. The windings of the alternating-current motor are designed for the forms of current, as single or multiphase, while in some forms there is only one set of windings. To learn all the points of difference you should study the books on the subject. A good general work on electricity is Thompson's Lessons.

(8721) C. T. M. asks: What is meant by a twenty per cent grade? A. A twenty per cent grade rises or falls 20 feet for every 100 feet measured horizontally and not on the slope. In other words, the grade is measured by the tangent of the angle of inclination and not by its sine, so that a 100 per cent grade corresponds to an inclination of 45 deg. and not to an inclination of 90 deg. A slope, as of an embankment, is usually designated as of so many to 1; for instance, the usual slope of earthwork is 1½ to 1, meaning 1½ horizontal to 1 vertical. But, conversely, the grade of a road is sometimes given as of 1 in so many, meaning a rise or fall of 1 foot vertically for so many feet measured horizontally; for instance, a grade of 1 in 20 would be a 5 per cent grade and of 1 in 5 would be a 20 per cent grade. You will find such matters explained in Trautwine's "Civil Engineer's Pocket Book."